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Northwest Manufacturing Initiative

Contract: SP4701-09-C-0039

Mr. Rick Evans, Principal Investigator

**Organization for Economic Initiatives, Inc.
1144 Gateway Loop, Suite 203
Springfield OR 97477-7750**

**Prepared By:
University of Oregon
Worksystems, Inc.
Ellen A. Fuller
J. Rick Evans**

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The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designed by other documentation.

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Foreword

The Organization for Economic Initiatives, Inc. (OEI) is pleased to submit this final progress report for SP4701-09-C-0039. We have provided both performance and fiscal oversight for the entire project, including the partner organizations of Worksystems, Inc. and The University of Oregon. Our oversight included project monitoring, site visits, and financial and performance reviews. This final report provides the details on both our collaborative research into sustainable defense supply chain and operations management, as well as the application of proven and highly effective workforce training models to improve the capabilities and responsiveness of Pacific Northwest defense manufacturers. Statements of the problems studied and summaries of the most important results can be found in the Executive Summaries of our collaborative partners. The detailed research data and specific applied training models can be found in the appendices.

Final Report for OEI-DLA-DoD 2009: Northwest Manufacturing Initiative

Executive Summary

Principal Investigator: Nagesh N. Murthy, Lundquist

College of Business, University of Oregon

This funding is a major part of building the research and teaching capacity of the faculty at the Lundquist College of Business to engage with the Industry in the Pacific Northwest (in particular with firms in the manufacturing eco-system of defense supply chains). Special emphasis was placed to increase the manufacturing competitiveness in the region by engaging in problem solving projects with firms, offering experiential education that can train and excite students to pursue thriving careers in operations and supply chain management, and undertake research to address the problems of import to the industry. A major emphasis was also placed on engaging in interdisciplinary and multi-disciplinary endeavors when possible.

Four major deliverables have been submitted as part of the final report for OEI-DLA-DoD 2009 initiative. These include:

- 1) Summary of 14 Field-Based Experiential Learning Projects
- 2) Technical Manuscript (research paper) titled, "Managing Engineering Design for Competitive Sourcing in Closed-Loop Supply Chains", by Tolga Aydinliyim and Nagesh Murthy. This problem was motivated by a design issue at Boeing that is likely to be pervasive across many supply chains (that involve machined components).
- 3) Technical Manuscript (research paper) titled, "Balancing Production, Inventory, and Delivery Costs in Paper Manufacturing", by Neil Geismar and Nagesh Murthy. This problem was motivated by a complex manufacturing and logistics challenge at a plant of International Paper Company (also faced by many packaging/paper firms in the region).
- 4) Technical Manuscript (research paper) titled, "Timing and Signaling Considerations for Recovery from Supply Chain Disruption" by Zhibin Yang and Nagesh Murthy. This problem was motivated by the supply chain disruptions during the aftermath of Tsunami in Japan. The model was refined after discussion with Director of Silicon sourcing at Intel and was also presented at Boeing.

We next provide a brief summary on each of the four deliverables.

Field projects dealt with problem solving and analysis on issues such as forecasting, process layout analysis and design, bottleneck analysis, quality control, inventory management, sourcing and procurement, capacity planning, justifying capital investments related to manufacturing, production planning and control, warehouse location or layout, and transportation logistics. A special effort was made to seek problems that address environmental issues in supply chain management. These sponsored projects were undertaken in Spring, 2009 and Spring, 2010 as part of the course in Supply Chain Management.

Technical Manuscript, "Managing Engineering Design for Competitive Sourcing in Closed-Loop Supply Chains", by Tolga Aydinliyim and Nagesh Murthy

We examine the strategic interplay between a buyer's design decision and the ensuing competition between suppliers in a three-tier closed-loop supply chain setting. We engage with an engineering design team at a major firm in the aerospace industry to study a problem scenario that manifests in the context of machined parts made from specialty materials (e.g., titanium alloys). The nature of engineering design decision in our research entails choice of integral versus partitioned design that has direct implications for the input raw material waste and ensuing competition between suppliers (i.e., incumbent and new).

Technical Manuscript, "Balancing Production, Inventory, and Delivery Costs in Paper Manufacturing", by Neil Geismar and Nagesh Murthy

We consider the operations of a single paper manufacturing plant that serves multiple clients by producing paper of various basis weights. A typical customer's order contains multiple jobs, each of which specifies paper of a certain weight and width. The plant combines jobs within each weight into sets, with no regard to which customer each job belongs. Costs are reduced by minimizing the number of sets produced. The high cost of transitions between weights encourages long production runs at each weight to minimize the number of transitions. As jobs are completed, they are released to distribution for delivery.

Deliveries are made by railcars, each of which is dedicated to one customer. Long production runs imply that maximizing railcar utilization requires holding the cars over several days or holding completed jobs within the loading facility. Each of these methods imposes a cost onto the distribution function. We find how distribution can minimize its cost, given production's schedule. We then consider the problem of minimizing the company's overall cost of both production and distribution. A computational study illustrates the cost reductions that can be realized by our proposed schemes.

Technical Manuscript, "Timing and Signaling Considerations for Recovery from Supply Chain Disruption", by Zhibin (Ben) Yang Nagesh Murthy.

We study the interaction between a supplier's timing of recovery *ex post* a disruption in a situation when the buyer has a backup production option. After disruption, the supplier quotes a recovery due date and makes recovery effort if the buyer chooses to wait for recovery. We find that the supplier's quote of recovery time affects the buyer's use of the contingency option in two ways. First, when the supplier possesses the flexibility of quoting any recovery due date, the supplier may use the quote as a strategic subsidy (by exploiting the two-tier penalty structure, intentionally incurring tardiness, and paying added penalty) to retain the buyer from invoking its backup option. Second, when the supplier has private information about the severity of supply disruption, the supplier uses the quote of recovery due date to signal the disruption severity. The supplier may be unable to credibly convey the severity level of disruption to the buyer.

Worksystems, Inc. Executive Summary

Worksystems, Inc. (WSI) is a nonprofit organization serving the City of Portland, Multnomah and Washington counties. The mission of the organization is to build a comprehensive workforce development system that supports individual prosperity and business competitiveness.

The organizational values essential to the growth and vitality of the system include:

- A skilled workforce that improves business and individual competitiveness, earning capacity, income and assets.
- Partnerships that support alignment, effectiveness and continuous improvement.
- High standards of accountability to the community.

In pursuit of its mission, Worksystems:

- Provides a single point of focus for regional workforce efforts.
- Builds linkages between regional government, business, labor, education and other leaders to enhance regional workforce programs and services.
- Invests in education, community-based and industry partners to provide skill development and related services.
- Supports projects to foster innovation, expand best practices and encourage system change.
- Coordinates workforce development activities with regional business, economic development and education strategies.
- Evaluates system quality and outcomes.

To ensure a responsive, demand driven workforce development system, WSI regularly engages targeted industry businesses to inform regional workforce services and investments. WSI has extensive experience in managing highly regulated Federal and state resources. Through this experience WSI has policies, processes and procedures in place to ensure that funds are spent on allowable and appropriate trainings. There are also advanced data systems and management protocols in place for monthly and quarterly monitoring of contract expenditures and program goals.

Serving as the fiscal and administrative agent for the workforce component of the NW Manufacturing Initiative, WSI awarded DLA funding to 19 Pacific NW defense contractors to support training for their existing workforce. All training was focused on continuous improvement across a variety of areas including: Leadership and Supervisory Training, Lean Manufacturing, Six Sigma Black Belt, train the trainer and technical support in implementing continuous improvement projects. All of the trainings were focused on streamlining processes, and increasing efficiency and effectiveness in either producing a more cost effective product or developing new products that support the defense industry. Several of these companies have expressed a need for additional training funds and new companies have requested training funds as well.

Appendix 1: Final Report Overview for OEI-DLA-DoD 2009

Final Report Overview for OEI-DLA-DoD 2009
Principal Investigator: Nagesh N. Murthy, Lundquist College of Business,
University of Oregon

This funding is a major part of building the research and teaching capacity of the faculty at the Lundquist College of Business to engage with the Industry in the Pacific Northwest. Special emphasis was placed to increase the manufacturing competitiveness in the region by engaging in problem solving projects with firms, offering experiential education that can train and excite students to pursue thriving careers in operations and supply chain management, and undertake research to address the problems of import to the industry. A major emphasis was also placed on engaging in interdisciplinary and multi-disciplinary endeavors when possible.

Four major deliverables have been submitted as part of the final report for OEI-DLA-DoD 2009 initiative. These include:

- 1) Summary of 14 Field-Based Experiential Learning Projects.
- 2) Technical Manuscript (Research paper) titled, “Managing Engineering Design for Competitive Sourcing in Closed-Loop Supply Chains”, by Tolga Aydinliyim and Nagesh Murthy. This problem was motivated by a design issue at Boeing that is likely to be pervasive across many supply chains (that involve machined components).
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We next provide a brief summary on each of the four deliverables.

Appendix A1: Overview for OEI-DLA-DoD 2009

Overview of Field-Based Problem Solving Projects

Instructor: Nagesh N. Murthy

Field projects dealt with problem solving and analysis on issues such as forecasting, process layout analysis and design, bottleneck analysis, quality control, inventory management, sourcing and procurement, capacity planning, justifying capital investments related to manufacturing, production planning and control, warehouse location or layout, and transportation logistics. A special effort is also being made to seek problems that address environmental issues in supply chain management. These sponsored projects were undertaken in Spring, 2009 and Spring, 2010 as part of the course in Supply Chain Management.

Confidentiality agreements were signed with sponsoring companies to elicit all the data required for these problem solving projects. The Principal Investigator has all the final reports submitted by the teams. Excerpts from these reports have been provided to provide a reasonable view of these projects without violating confidentiality issues. Some of these reports have been converted from PDF files to a Word document resulting in loss of some formatting. The Principal Investigator would be glad to furnish the reports if needed for audit, but did not deem it to be appropriate to put the entire report in public domain.

Field Projects Organized and Supervised by Nagesh Murthy in Spring 2009:

1) Process Flow (i.e., Value Stream) Mapping at Kettle Foods Project

UG Team: Adre VanDeHey, Katie Clapper, Kenta Nakajima, Robert Shea, and Sean Labasan

Industry Sponsor: Joe Iagulli, Director of Supply Chain Management

2) Carbon Emission Analysis at Myers Container Project

UG Team: Andrew Ellsberg, Aron Moore, Jeff Stratman, and Jordan Matin

Industry Sponsor: Cody Stavig, Plant Manager; Taylor Gordon, System Analyst

3) Freight Analysis at Myers Container Project

UG Team: James Keane, Robert Kirkpatrick, and Philip Lorenz

Industry Sponsor: Cody Stavig, Plant Manager; Taylor Gordon, System Analyst

4) Greening Procurement of Office Supplies at Northwest Natural

MBA Team: Bob Cherney, Danielle Isidore Harry, Maria Dossin, Brandon Hern

Industry Sponsor: Bill Edmonds, Director of Environmental Policy and Sustainability;
Holly Meyer

5) Greening Procurement of Custodial Supplies at Northwest Natural

MBA Team: Li Feng, Kevin Johnson, Justin Overdeest, Dan Tremblay

Industry Sponsor: Bill Edmonds, Director of Environmental Policy and Sustainability;
Holly Meyer

6) Supply Chain Optimization Project at YAKIMA

MBA Team: Susan Einberger, Colin Geartiy, Eugene Gonzales, Brooke Standifer, Ben West

Industry Sponsor: Mike Steck, Senior Director, Customer Marketing and Sustainability;
Josh Creasman, Director of Supply Chain

7) Supplier Coordination with Merge in Transit for Shipments at Silver Eagle

Manufacturing Company (Did not provide the report in electronic format. Hard copy is available upon request).

UG Team: Taylor Chittick, Leon Sanchez, Scott Rieders, Jiyoung Yoon, and Matt Benjamin

Industry Sponsor: Ali A Saalabian, VP of Operations; Randy Urness

Field Projects Organized and Supervised by Nagesh Murthy in Spring 2010:

1) Commodity Costing Project at Monaco RV

UG Team: Dareus Robinson, Bondy Black and Brad Hoeren

Industry Sponsor: Dennis Girod, Purchasing Manager

2) Freight Optimization Project at Myers Container

UG Team: Vanessa Sin, Raymond Santosa, Jesse Denham, and Sean Loud.

Industry Sponsor: Taylor Gordon, System Analyst

3) EWEB Warehouse Relocation Project

MBA team: Greg Carlson, Jia Hu, Jaxon Love, Erin Malone, and Hendrik Van Hemert

Industry Sponsor: Keith Engel, Lile Moving and Storage; Rick Motley, Warehouse Manager, EWEB

4) Warehouse Design for Inbound Materials at Monaco RV

UG Team: Malia Harada, Alexi Wilson, Drew Kroeplin, and Scott Fogel

Industry Sponsor: Dennis Girod, Purchasing Manager

5) Organically Grown Company Product Coding Project

MBA Team: Doug Anderson, Katie Brennan, Paul Clark, Kelly McKeag, and Dan Simon

Industry sponsor: Josh Hinerfeld, CEO; Jason Smith; Waylon Spoden; Robbie Vasilinda

6) Supply Chain Management Project at StoveTec

MBA Team: Brett Ratchford, Tracy Reyes, Linda Anson, and Mohammad Rashid

Rasool

Industry Sponsor: Ben West, General Manager; Miles Makdisi, Office Manager

7) Inventory management System Analysis II at Myers Container

UG Team: Greg Zimet, Luke Leon, Katelyn Sanders, and Eric Eszlinger

Industry Sponsor: Taylor Gordon, System Analyst.

Managing Engineering Design for Competitive Sourcing in Closed-Loop Supply Chains

Overview

Tolga Aydinliyim, University of Oregon

Nagesh N. Murthy, University of Oregon

Background and Problem Context:

Engineering design for environment considerations have gained increased attention for physical, discrete, engineered, and manufactured products due to the need for addressing end-of-life challenges from a cradle-to-cradle perspective. Strategies of remove, reduce, reuse, refurbish, and recycle need a proactive consideration during product design and development in order to realize end-of-life strategies in an effective manner. While much of the focus has been on end-of-life considerations, there are significant challenges that persist in the area of environmentally-conscious design for manufacturing. Engineering design choices with regards to product architecture and the associated manufacturing process can have a significant impact on the ensuing competition between the suppliers, level of raw materials used (in spite of recycling), and overall productions costs.

We engage with an engineering design team at a firm to study a problem scenario in the aerospace industry that manifests in the context of machined parts made from specialty materials (titanium alloys). We use a simple stepped shaft shown in Figure 1 below to illustrate the product-process design choices that manifest in our problem context for a cylindrical machined component produced from a blank (cut from a bar-stock).

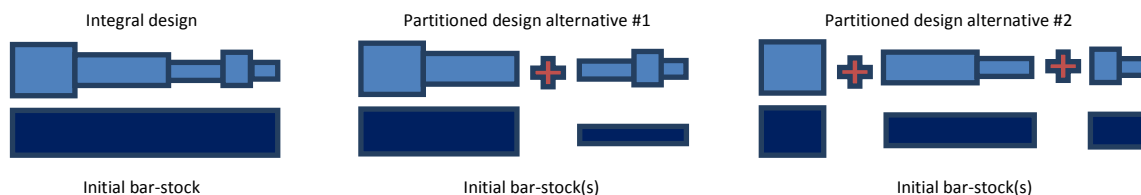


Figure 1. Sample design alternatives and the required bar-stocks before machining/material removal.

As seen in Figure 1, this component can be produced as a single piece (i.e., using an integral design) by machining a large blank of the requisite size. It can also be produced by joining two or more pieces produced by machining smaller blanks of the requisite sizes (i.e., using a partitioned design). The integral design architecture does not entail any joining cost or issues of yield loss on account of joining by the buyer. However, it requires a larger amount of raw material, higher material removal, and consequently higher amount of material that needs to

be recycled. In contrast, the partitioned design architecture requires lower amount of raw material to begin with, significantly lower material removal, and consequently lower amount of material for recycling. But the partitioned design entails joining costs and yield loss on account of defect in joining. In any given situation, the component geometry would dictate the extent to which one could consider partitioning. Moreover, given the detrimental effect of partitioning on yield loss, one may be constrained to consider partitioning within the permissible limit for yield loss.

The integral design for large components tends to limit the supply base to some specialty suppliers. The current practice followed by our industry partner (the buyer) is to rely mainly on the integral design procured from a specialty supplier (the incumbent supplier), which is a joint venture between the buyer and the largest titanium producer in the world (the bar-stock manufacturer). To ensure that the excessive amount of removed material is fully introduced back to the bar-stock manufacturer's mill, this incumbent supplier is strategically located close to the bar-stock manufacturer. The engineering design team we engaged with is considering partitioned design alternatives which will be simpler, and thus extend the supply base to a point that can create significant competition between incumbent specialty supplier and alternative suppliers (the new suppliers). However, the new suppliers would be geographically dispersed, and hence, have to rely on third-party recyclers resulting in imperfect reverse material flows for scraps. These differential opportunities, restrictions, and tradeoffs create interesting closed-loop dynamics for a buyer to make design architecture choices while being cognizant of the ensuing material waste recycling streams, and the supplier selection and demand allocation decisions. In Figure 2, we describe the interactions between the involved parties in the context of the scenario for our industry partner.

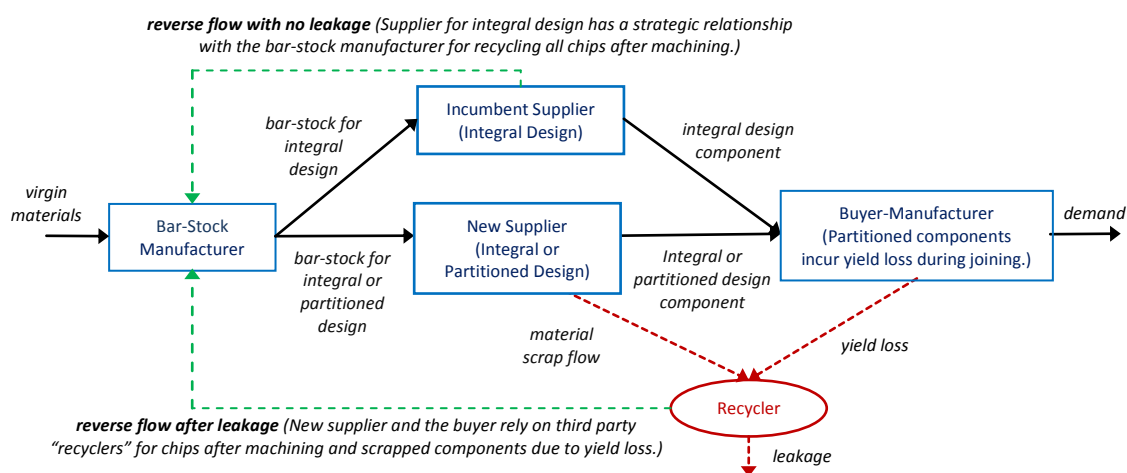


Figure 2. The framework we use to capture the material/bar-stock/component flows among the parties involved.

Positioning of Our Work and the Research Questions:

Our research can be most directly related to three streams in the literature, namely (a) strategic product/engineering design with implications for closed-loop supply chains; (b) competition with reverse flows; and (c) strategic design of reverse logistics policies and infrastructure. To the best of our knowledge we study a rather new problem situation that has hitherto not been considered in the literature. The insights not only benefit scenarios wherein expensive and specialty materials are used in machined components in relatively low volume environments but also high volume components that are made from a high variety of recyclable materials and use material removal processes during fabrication. From a managerial perspective, we provide the ability to consider a closed-loop analysis while incorporating competition in situations wherein there is significant recycling of materials in the supply chain. Our model highlights new opportunities and insights for managers who typically consider only an open-loop analysis to address downstream implications (including incorporating salvage value of scrap) while having a limited ability to explicitly incorporate competition. Specifically, we address the following questions of strategic and tactical interest to managers:

1. **Design decision of the buyer:** Under what conditions would the buyer consider an alternative (partitioned) design? What optimal level of partitioning does this alternative design entail, and when does the buyer optimally restrict its design choice to the integral design?
2. **Sourcing decision of the buyer:** How would the firm allocate its demand to its suppliers? For example, sole source the integral design, dual source the integral design, dual source by sourcing each design (integral and optimally partitioned) from respective suppliers.
3. **Sensitivity of the optimal decisions:** How sensitive is the optimal design and sourcing policy of the buyer (i.e., robustness of design and ensuing sourcing) to the changes in (a) the buyer's sensitivity to each supplier's price, (b) the raw material requirements for the integral design vis-à-vis the degree to which it can be partitioned, (c) leakage in the reverse flows of scrap material, and (d) virgin material and scrap material prices?
4. **Competition between the suppliers:** How severe would price competition be under the optimal design and sourcing scenario? To what extent can the buyer firm induce the suppliers to cut their prices?
5. **Recycling implications:** How would the buyer's and the incumbent integral design supplier's profits change if the incumbent cannot maintain its reverse flow advantage?

Overview of the Analysis and Findings:

To provide managerial insights for design and manufacturing engineers and supply chain managers grappling with understanding the strategic implications of engineering design choices on sourcing and procurement, we employ a two-stage game theoretical analysis of the interaction between the buyer and the two suppliers. In the first stage the buyer solves an optimal product design problem with the objective of minimizing the sum of procurement and joining costs net of possible salvage revenue in case there is yield loss (where the latter costs/revenues are relevant if it is optimal to consider the alternative partitioned design). In the second stage, the incumbent integral design supplier and the alternative (integral or partitioned design) supplier engage in simultaneous price competition. The buyer's design choice and the effective return rate of scrapped material through third-party recyclers affect virgin material requirements of the alternative design supplied by the new supplier, and subsequently have an impact on each supplier's price quote. Given the prices quoted by both suppliers the buyer allocates demand to each supplier according to a classical endogenous demand model with price elasticity and cross price elasticity effects.

The buyer's optimal design decision, the equilibrium prices this decision induces the suppliers to quote, and the resulting demand allocation imply the following design-sourcing policy alternatives: **1. *S-PD (Sole–Partitioned Design)***: The integral design supplier is priced out, and the buyer procures only the optimal partitioned design from the new supplier. **2. *D-max (Dual–Maximally Partitioned Design)***: The buyer procures the integral design from the incumbent supplier, whereas the new supplier supplies maximally partitioned design, i.e., the partitioned design with the least amount of raw material bar-stock requirements or the one with the maximum allowed yield loss due to joining. **3. *D-part (Dual–Partially Partitioned Design)***: The buyer chooses an optimal partitioned design that is not fully partitioned (as opposed to the one implied by policy 2—see above) and allocates optimally between the incumbent integral design supplier and the alternative partitioned design supplier. **4. *D-ID (Dual–Integral Design)***: It is not optimal for the buyer to consider an alternative partitioned design, but the buyer dual sources the integral design from both the incumbent and the new supplier. **5. *S-ID (Sole–Integral Design)***: The new supplier is priced out, and the buyer procures only the integral design from the incumbent supplier.

We find that it is never optimal for the buyer not to procure from the incumbent supplier, whereas the new supplier will be priced out in equilibrium (a) when the buyer's demand allocation is significantly more sensitive to the new supplier's price than it is to the incumbent's price (implying the buyer's unwillingness to consider alternative designs—possibly due to yield loss

and quality considerations), (b) when the return rate via third-party recyclers is low and the bar-stock raw material requirement for the integral design is high (implying a complex geometry), or (c) when the virgin material costs as well as potential salvage revenues are high (implying a cost advantage to the incumbent supplier—reflected on the low price it can quote to the buyer). The optimal design decision relates to the optimal sourcing decision in non-intuitive ways. We find that the more the buyer is willing to consider dual sourcing, the less partitioned the optimal design choice becomes. As a result, the shortcomings of the new supplier such as the imperfect scrap material reverse flows and the subsequent increased reliance on expensive virgin materials become more significant, causing the new supplier to quote higher prices. Consequently, the incumbent supplier increases its demand share, which allows him to generate higher salvage revenue, reduce costs and quote even lower prices. Accordingly, supplier competition resulting from the buyer's design choice causes the profits of both suppliers to plummet for different reasons; whereas the new supplier loses demand, the incumbent supplier has to enjoy lower margins.

To assess how the incumbent supplier's "full recycling" advantage benefits the supply chain, we compare the buyer's optimal cost and the incumbent supplier's optimal profit in our base model to the equilibrium attained when the incumbent supplier also recycles using the third-party. We find that this strategic partnership between the buyer and the incumbent supplier is beneficial to both parties as it helps reduce the break-even production volume required to justify the investment to achieve the advantage. Moreover, the incumbent's profit loss without full recycling is much more significant (4-8 times percentage-wise) than the increase in the buyer's optimal cost, suggesting that, in the presence of competition with the supplier of the alternative partitioned design, the incumbent must maintain healthy reverse scrap material flows.

“Balancing Production, Inventory, and Distribution Costs in the Paper Industry”

Overview

Neil Geismar, Texas A&M University

Nagesh N. Murthy, University of Oregon

Paper manufacturing is a quintessential continuous process, so much is known concerning how to optimize this production. Very few studies have considered the distribution problem for a paper manufacturer or how cooperation between the Production and the Distribution functions could reduce the company’s overall costs. We investigate these problems based on information gathered through our interactions with the management of a paper mill in the Pacific Northwest.

Production produces large rolls of paper that are cut into specific widths to create *jobs* that are used to fill to customers’ orders. Because it is focused solely on production efficiency, Production consolidates jobs into rolls with no consideration of to where a job will be sent. Thus, the order in which jobs are released to Distribution is random with respect to the jobs’ customers, i.e., the jobs of any customer are not consolidated temporally, which would help Distribution reduce its storage costs.

Distribution delivers this finished paper to its customers via railcars. Each car is dedicated to one customer, and, since car rental is Distribution’s largest expense, it prefers to dispatch full cars. A train departs the mill at the end of each day, and Distribution decides which cars are part of that train. A car holding some paper may be held overnight so that it carries more paper when it is eventually dispatched. This leads to a *demurrage* charge, which Distribution may bear to increase the railcars’ utilization.

Distribution must determine how to load each customer’s jobs for the current planning horizon onto railcars so that the number of railcars rented is minimized. This in itself is an NP-hard Bin-Packing problem. Following that, Distribution should minimize storage costs, which include demurrage and a cost for holding finished jobs inside the facility overnight. Thus, a solution requires for each customer a schedule of each car’s arrival and departure, which jobs are carried on each car, and how those jobs are configured to maximize utilization of the car.

We solve this problem for two different environments. The first applies to a general paper mill: jobs of any width are allowed. We solve this with a custom algorithm that uses the First Fit Decreasing procedure for solving Bin-Packing problems. The algorithm also creates a network whose nodes represent the days of the planning horizon and whose arcs represent the costs of combining jobs from those days into one set of railcars. The best combination is represented by

a shortest path within that network. A dynamic program then minimizes the total storage for jobs not delivered on their production dates. We demonstrate how and under what circumstances the plant can reduce costs by dispatching cars that are *not* full, rather than having them wait an additional day for more jobs to be loaded onto them.

The second environment is specific to the above-mentioned mill. Its jobs' widths, based solely on the mill's customers' orders, are all greater than one-third of a railcar's height. This allows us to prove analytic results concerning the loading of cars and to develop an algorithm that finds an *optimal* solution to Distribution's problem. In addition to First Fit Decreasing, this algorithm uses the Blossom Algorithm for the Maximum Weight Matching Problem on a Non-Bipartite Graph and a recursive procedure that is guaranteed to converge in polynomial time.

The computational study compares, for general data, our solution to the mill's current practice and to a lower bound that we derived for the optimum cost for various parameter combinations. Obviously, this lower bound is not tight, since it was designed to run in polynomial time and the problem is NP-hard. Our proposed method reduces Distribution's cost by an average of 39.12% for the general case. The solution averages 10.3% above the lower bound.

We also propose a method for cooperation that will increase Production's cost but may decrease Distribution's cost by a larger amount. The efficacy of this process and the parameter relationships for which it is best suited are investigated via a computational study. Having Production and Distribution cooperate reduces the overall cost by an additional 4.40%, on average.

Timing and Signaling Considerations for Recovery from Supply Chain Disruption

Overview

Zhibin Yang, University of Oregon

Nagesh N. Murthy, University of Oregon

Introduction:

Supply chain disruptions are a major concern for firms because of the detrimental impact on their operational and financial performance. Natural disasters (e.g., earthquakes, hurricanes, tsunamis, volcanoes, floods), operational failures (e.g., fire hazards, information system failures), political instabilities, and labor strikes, among others have been known to cause severe disruption in supply chains of a variety of industries. Original Equipment Manufacturers (OEMs) in several industries have also increased their reliance on a small number of key specialty suppliers for supplies of cutting edge materials, product modules, and components. There are several instances wherein a severe disruption at the only (or major) facility of a single-sourced component supplier has wreaked havoc in the supply chains of the entire industry (e.g., a major supply shortage of cell phone chips caused by a minor fire at Philips's facility in New Mexico in 2000; flooding of Seagate's two major factories in Thailand is expected to cause a major shortfall for the computer industry through 2012). Furthermore, as many supply chains have resorted to contract manufacturing for lowering cost and have got more far flung and geographically dispersed in their tiers, the OEMs have all too often lost visibility in the lower tiers of their supply chains. This has at times undermined their abilities to anticipate and withstand shock of supply chain disruption (e.g., Menu Foods' recall of pet-foods in North America in 2007 that were contaminated by sub-quality gluten produced by a Chinese manufacturer).

With the occurrence of many highly conspicuous disruptions in recent years, supply chain firms pay increased attention to supply risk mitigation and business continuity planning to reduce the detrimental impact of disruption. Under the menace of disruption, the supplier prepares itself for speedy recovery to normal operations once disruption occurs, and the buyer searches for backup options and defines in its continuity plan the contingencies that trigger the execution of such options. While it is quite plausible that certain parameters that govern post-disruption risk mitigation, such as penalty for supply delays or incentives for speedy recovery, are stipulated in the contingency clauses, the actual nature of severity of disruption, ensuing effort needed by the supplier to recover, and the detrimental impact on the buyer only become

apparent after the disruption occurs. This leaves room for the supplier and the buyer to strategically plan their respective courses of action *ex post* disruption, such as the supplier's execution of recovery effort and the buyer's invocation of contingency actions.

Complicating this situation is the possibility that the supplier is privileged with better information about the nature of disruption and its damage, since the suppliers is in a better position to assess its own condition *ex post* disruption. For example, at the occurrence of disruption, the supplier is in a unique position to make first-hand, accurate, and timely assessment of the severity of damage to its capacity and operations, and keep it as private information if needed. Since the damage and the amount of effort taken to full recovery is generally increasing in the severity level of disruption, asymmetric information about disruption's severity reduces the buyer's visibility of the supplier's ability to make a speedy recovery.

In this study, we consider a scenario wherein a supplier is faced with a disruption and hence ceases to produce, and consequently the buyer faces a disruption in supply. The supplier knows the severity of disruption, and defines and proposes a recovery plan in an effort to retain the buyer's business. Given the adverse impact due to the loss of supply, the buyer is faced with a choice to immediately switch to a backup source of supply (albeit by incurring a significant cost) or wait till the supplier recovers from disruption and resumes supply. But, the buyer's decision is hindered by a lack of information about the disruption's damage to the supplier. We want to explore the strategic interaction between the supplier and the buyer in the stage *ex post* supply chain disruption. Specifically, we aim to answer two research questions. First, after the occurrence of supply chain disruption, how does the supplier plan its recovery to retain the buyer, who is pressed to consider invoking the backup option for its business continuity? In this regard, we identify the value of strategically inserting tardiness (albeit counterintuitive) into the supplier's recovery schedule. Second, how does asymmetric information about the severity of disruption affect the supplier's recovery effort and its ability to retain the buyer's business, and affect the buyer's use of its contingency option? In this regard, we find that the supplier may strategically conceal disruption's damage by distorting its recovery plan that is visible to the buyer, thus hindering the buyer's abilities to accurately assess disruption's damage and reckon its contingency action.

Our work is related to the literature on supply chain risk management. (Please refer to Tomlin and Wang 2010; and Aydin et al. 2012 for reviews.) The majority of extant work in this literature focuses on strategies for planning for and reducing the risk *ex ante* supply chain disruption. To the best of our knowledge, our research is among the earliest works that address strategic interactions between buyer and supplier in managing post-disruption risk. There is a

stream of research in supply chain disruption risk management that studies situations wherein there is significant asymmetry in information with regards to the risk in supply (Lim 2001; Baiman et al. 2000; Gurnani and Shi 2006; Yang et al. 2009, 2011; Tomlin 2009; Chaturvedi and Martínez-de- Albéniz 2011; and Gumus et al. 2012). Our research also features asymmetric information in supply chain risk management, but deviates from these works by focusing on information asymmetry that arises only after the occurrence of disruption.

Model:

We model a supply chain of one buyer and one supplier who pre-committed one unit of supply to the buyer. At time zero, disruption occurs and the supplier loses the supply. To set an expectation for the buyer, the supplier reports the due date for full recovery to the buyer. Given the due date promised by the supplier, the buyer decides whether to wait for the supplier's recovery or to invoke the buyer's backup option. If the buyer chooses to wait, the supplier commences the recovery process. We assume that the supplier's recovery completion time is perfectly deterministic, and the supplier has full control of the completion time by investing more in recovery effort. Specifically, the supplier's cost of conducting a full recovery is a decreasing and convex function in the recovery completion time. The more time allowed for recovery effort, the less costly it is; as the recovery completion time is relaxed, the marginal cost reduction from having more time diminishes. The buyer incurs a cost per unit of time waiting for the supplier's recovery. For every unit of the buyer's waiting time, the supplier pays the buyer a penalty as compensation. Furthermore, if the supplier completes recovery after the pre-set due date, the penalty rate is boosted to a higher level. Alternatively, if the buyer chooses to invoke the backup option, the buyer terminates the contract, and receives a one-time refund from the supplier. The buyer incurs a cost for exercising the backup option. We first analyze the model where all information is common information in the supply chain, and relax this assumption later. Note that our model setting is quite general and insights are robust to account for situations wherein the supplier's backup option too may need some time to resume supply or the buyer has some inventory to buffer the detrimental impact of disruption for a while.

Analysis and Results:

We first solve the model under symmetric information for the supplier's optimal due date quoted to the buyer and the optimal recovery completion time. In general, the supplier retains the buyer when the buyer's cost of waiting for recovery is less than its cost of invoking the backup option. We find, however, that even if the latter cost is relatively low, the supplier can

still induce the buyer to wait for recovery. The supplier strategically inserts tardiness into its recovery schedule, by setting the recovery due date to be earlier than its economic completion time. By doing so, the supplier alleviates the buyer's cost of waiting for recovery with a payment sweetened by tardiness penalties. The buyer now finds it economically viable to wait for recovery, even though the supplier is not planning to complete recovery any sooner. As a result, both the buyer and supplier are better off, compared to the case where the supplier is restricted to complete recovery on time. Our finding has two merits. First, as randomness in recovery is commonly blamed as a culprit for tardy recoveries, our finding offers an alternative explanation to why disruption recovery is tardy even if the recovery process is perfectly reliable. Second, our result demonstrates that allowing tardiness in recovery can *Pareto*-improve the supply chain members' performance in recovering from disruption.

In the preliminary analysis above, we identify the supplier's strategic use of the recovery due date under the condition that the buyer has same information as the supplier. We now explore the situation where the supplier is better informed than the buyer regarding the severity of disruption and its ramifications and keeps its information undisclosed to the buyer, causing asymmetric information in the supply chain. To analyze this problem of asymmetric information, we study a variation of the basic model in which the severity level of disruption is assumed to be the supplier's private information. Specifically, we assume that a higher severity level necessitates a higher cost for the supplier to make timely recovery. We analyze this problem as a signaling game, where the supplier's disruption severity is either *high* or *low* and the buyer holds a probabilistic estimate of the severity level. Under symmetric information, the buyer tends to accept a long due date for recovery only if the supplier's disruption is known to be of low severity. Under asymmetric information, the supplier under high-severity disruption has an economic incentive to quote a long due date to alleviate its cost of recovery, mimicking the supplier condition under disruption of low severity. The buyer can no longer reliably tell whether the disruption severity is low or high. Instead, the buyer uses the quoted due date as a signal to update its estimate of the severity level, and chooses recovery versus the backup option according to its updated estimate.

To present our main finding in brevity, we focus on the case where the buyer's cost of invoking the backup option is so low that the supplier must strategically quote a shorter due date in order to retain the buyer. We find that there exists a unique pooling equilibrium, in which for both severity types the supplier quotes the same due date to the buyer. This result implies that, when the supplier has an incentive to use the due date as a strategic instrument for buyer

retention, there is no reliable way for the buyer to distinguish the true disruption severity of the supplier, and the supplier has no intention to share its information.

Furthermore, the due date quoted by the supplier at this pooling equilibrium is later than that quoted by the supplier when the severity of disruption is high, but is earlier than that when the severity of disruption is low. In other words, asymmetric information mitigates the strategic distortion to the due date quoted by the high-severity type, but amplifies it with the low-severity type. To gain insight, we examine supplier's incentives for both severity types under asymmetric information. Under asymmetric information, since the buyer cannot reliably tell the severity level of disruption from the supplier's due date signal, the supplier under high-severity disruption tends to take advantage of it by quoting a long due date. On the flip side, since the buyer is uncertain that a long due date must indicate that the supplier's severity of disruption is low, the supplier under low-severity disruption is forced to quote a shorter due date to avoid pushing the buyer away from waiting for recovery. Therefore, asymmetric information reduces the supplier's strategic need to quote an early due date under disruption of high severity, but augments it under disruption of low severity.

Conclusion:

In summary, we examine the supply chain's recovery from a supplier disruption. Our study deviates from other works in the supply chain disruption literature by focusing on the supply chain members' strategic interactions *ex post* disruption. We find the supplier's interesting use of the due date as a strategic instrument for buyer retention. This finding contributes an alternative explanation to the understanding of tardiness in recovery. Our results also generate insights on the effect of asymmetric information on the supply chain's recovery and the supplier's strategic behavior.

**Appendix A2: Sponsored Projects in Supply Chain Management Elective offered
for Undergraduates and MBAs: DSC 477/577, Spring 2009**

**Field-Based Experiential Learning Projects Undertaken Under the Auspices of OEI-DLA-
DoD 2009 Initiative**

**Sponsored Projects in Supply Chain Management Elective offered for
Undergraduates and MBAs: DSC 477/577, Spring 2009
Faculty Adviser: Nagesh N. Murthy**

The projects have been listed below. Confidentiality agreements were signed with sponsoring companies to elicit all the data required for these problem solving projects. The Principal Investigator has all the final reports submitted by the teams. Excerpts from these reports have been provided to provide a reasonable view of these projects without violating confidentiality issues. Some of these reports have been converted from PDF files to a Word document resulting in loss of some formatting. The Principal Investigator would be glad to furnish the reports if needed for audit, but did not deem it to be appropriate to put the entire report in public domain.

Process Flow (i.e., Value Stream) Mapping at Kettle Foods Project

UG Team: Adre VanDeHey, Katie Clapper, Kenta Nakajima, Robert Shea, and Sean Labasan

Industry Sponsor: Joe Iagulli, Director of Supply Chain Management

Carbon Emission Analysis at Myers Container Project

UG Team: Andrew Ellsberg, Aron Moore, Jeff Stratman, and Jordan Matin

Industry Sponsor: Cody Stavig, Plant Manager; Taylor Gordon, System Analyst

Freight Analysis at Myers Container Project

UG Team: James Keane, Robert Kirkpatrick, and Philip Lorenz

Industry Sponsor: Cody Stavig, Plant Manager; Taylor Gordon, System Analyst

Greening Procurement of Office Supplies at Northwest Natural

MBA Team: Bob Cherney, Danielle Isidore Harry, Maria Dossin, Brandon Hern

Industry Sponsor: Bill Edmonds, Director of Environmental Policy and Sustainability; Holly Meyer

Greening Procurement of Custodial Supplies at Northwest Natural

MBA Team: Li Feng, Kevin Johnson, Justin Overdeest, Dan Tremblay

Industry Sponsor: Bill Edmonds, Director of Environmental Policy and Sustainability; Holly Meyer

Supply Chain Optimization Project at YAKIMA

MBA Team: Susan Einberger, Colin Geartiy, Eugene Gonzales, Brooke Standifer, Ben West

Industry Sponsor: Mike Steck, Senior Director, Customer Marketing and Sustainability; Josh Creasman, Director of Supply Chain

Supplier Coordination with Merge in Transit for Shipments at Silver Eagle Manufacturing

Company (Did not provide the report in electronic format. Hard copy is available upon request).

UG Team: Taylor Chittick, Leon Sanchez, Scott Rieders, Jiyoung Yoon, and Matt Benjamin

Industry Sponsor: Ali A Saalabian, VP of Operations; Randy Urness

Process Flow (i.e., Value Stream) Mapping at Kettle Foods Project

UG Team: Adre VanDeHey, Katie Clapper, Kenta Nakajima, Robert Shea, and Sean Labasan

Industry Sponsor: Joe Iagulli, Director of Supply Chain Management

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2009

Executive Summary

With complex operations in the Kettle Foods plant in Salem, management faces the challenge of not being able to easily share this information with existing staff and new hires. The baking and frying process is well known by only a small number of people in the facility. As a result, Kettle Foods would like to create a process flow diagram which will help educate their employees, and thus collaborated with students from Nagesh Murthy's Supply Chain Management class at the University of Oregon.

The goal for this project was to provide our sponsor at Kettle Foods, Joe Iagulli, with the aforementioned flow diagram. In order to complete this deliverable, we made two visits to the plant and observed the production process, as well as discussed the process with Mr. Iagulli, who is the Director of Supply Chain. Based on these visits, we were able to establish 17 elements of the process taking place at the Salem facility.

Our group created a detailed process flow diagram which includes a breakdown of each of the 17 stages; for each stage, vital information associated with it has been highlighted. This includes capacity levels, inventory schedules, incoming raw material levels, and other key statistics.

This chart will provide the Kettle Foods management with a better way for new hires to learn the production process, as well as enable future groups from the University of Oregon to begin with a higher level of understanding and ultimately be more productive over the course of the project.

Background

This report is the initial phase of collaboration between Kettle Foods and the University of Oregon. With a complex facility, knowledge of the entire plant's process flow exists in a small percent of the employees. Having the ability to provide a thorough understanding of operations

to new hires without having to physically walk them through the plant will not only save time, but also set them up to make more informed decisions.

Context

Management at the Kettle Foods plant in Salem, Oregon has requested a process flow diagram of their plant that will make the two following items possible:

- New plant employees can be briefed with the chart instead of having to take a full walking tour of the plant
- Future groups working with Kettle Foods from the University of Oregon will be able to begin with a higher level of understanding.

When new employees are hired, they do not have a full working knowledge of the plant. There are few people in the facility with the knowledge required to brief those hires on this information. Having a process flow diagram to use in training new employees will benefit Kettle Foods as time spent potentially giving long tours can be spent on more productive activities. Additionally, this level of understanding throughout the team will put them in position to make better decisions as a whole.

Another purpose of this diagram is to assist future groups from the University of Oregon so that they may have a base level of understanding about the company when they begin their projects. This will enable teams to be more efficient from the start and ultimately deliver a stronger product.

Scope

This project is sponsored by Joe Iagulli, Director of Supply Chain, Kettle Foods. The time period is the Spring 2009 term at the University of Oregon. The final deliverables are due to Mr. Iagulli at Kettle Foods and Professor Nagesh Murthy at the University of Oregon no later than 6:00 pm on June 5, 2009.

Solution Methodology

To complete our stated objectives, we engaged with Mr. Iagulli both in person at the plant as well as through email. The first visit to the plant was used to establish a general knowledge of the elements of production. Once a draft of process flow had been created, we made a second trip through the plant where more detailed information for each stage was collected.

Carbon Emission Analysis at Myers Container Project

UG Team: Andrew Ellsberg, Aron Moore, Jeff Stratman, and Jordan Matin

Industry Sponsor: Cody Stavig, Plant Manager; Taylor Gordon, System Analyst

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2009

Project Scope

Our group was assigned with the task of examining the various supply chain operations for Myer's Containers, LLC and determining its overall carbon footprint. Our goal was to make a calculation of carbon emissions related to the operations and logistics associated with new barrel manufacturing at the Killingsworth Facility. Our direct objectives were to:

- Develop a strategy for measuring relevant emissions
- Measure the emissions associated with their operations/transportation
- Itemize their emissions by source
- Calculate the cost of appropriate carbon offsets for each itemized function.

Our contact for this project was Taylor Gordon. Initial contact was established through a conference call where we were given some basic logistics of their facility. We then drove to the facility for a tour, with Taylor as our guide. We were able to identify a number of problematic and wasteful issues immediately. After the tour, we requested some data from Myer's, such as their various utilities bills, transportation and freight information, and anything else that they thought would be relevant to our project. Through extensive research, we were able to determine the coefficients associated with various carbon emissions and apply that to the data we received from Taylor.

What are Carbon Emissions/Offsets?

A carbon emission is carbon dioxide that is released into the atmosphere, primarily by the combustion of fossil fuels in energy use. As greenhouse gases, such as carbon dioxide, are released into the atmosphere they attributed to global warming. A carbon offset is a financial instrument aimed at a reduction in greenhouse gas emissions. One carbon offset represents the reduction of one metric ton of carbon dioxide or its equivalent in other greenhouse gases. Some examples of offsets are: renewable energy, methane collection and combustion, energy efficiency, destruction of industrial pollutants, and reforestation efforts.

Myer's Sources of Supply Chain Emissions

There are several points along Myer's supply chain that create considerable carbon emissions. Likely the biggest one, although not a direct source of Myer's production, is from the manufacturing of their most basic raw material, steel. We did not estimate how much carbon is emitted in making the steel supplied to Myer's. Although we did not calculate it, Exhibit 5 shows the carbon conversion factors related to production in the steel industry.

Another type of carbon-based pollutant that is being released in Myer's production of steel barrels is Volatile Organic Compounds (VOC). VOCs are chemicals that are mostly used as paint thinners and liners, and they become Hazardous Air Pollutants (HAP). HAP emissions are regulated by the U.S. Environmental Protection Agency (EPA), and Myer's has been able to consistently avoid sanctions by staying within the regulated amounts. This is not to say that their HAP emissions can't still be reduced, and our recommendation for doing so will be discussed later in this report.

Myer's uses electricity to power their production equipment, air conditioning, lights, computers, and various other office and factory equipment. They also use a great deal of natural gas to heat their factory. We found a carbon calculator on the EPA website to help us determine how much carbon dioxide is emitted by the use of their various power sources. The data related to electricity and gas is displayed in Exhibit 2.

The main, direct source of carbon emissions in Myer's supply chain is from their freight operations. Trucks come into Portland from Chicago and Merced, CA carrying sheets of steel (Myer's raw materials). They then send their finished products out on trucks to businesses and other customers all over the continent. All of these outbound trucks, often traveling long distances, are huge sources of carbon emissions. The data for freight is displayed in Exhibit 4.

The last relevant source of emissions that we considered is one that may often be overlooked – employee commuting. Taylor told us the amount of employees that were living about how far away, as well as how many take public transit to work. We used those numbers to come up with a monthly estimate for emissions resulting from employee commuting. This data is displayed in Exhibit 5.

Carbon Calculator

In this section we will be going over the specifics of the carbon calculator. It was built by directly inputting information into Microsoft Excel. We mention this as it is important to periodically update the information when advances are made in areas such as transportation fuel efficiency or carbon content of the fuels used. It is currently designed to calculate carbon emission for a month of production, but it can be easily scaled to whatever length of time the user requires.

Summary Section

This is where the barrels produced, total pounds of carbon emitted, tons of carbon emitted, prices per offset, total cost of offsetting, and a per barrel breakdown of the price of offsetting are located.

Freight Analysis at Myers Container Project

UG Team: James Keane, Robert Kirkpatrick, and Philip Lorenz

Industry Sponsor: Cody Stavig, Plant Manager; Taylor Gordon, System Analyst

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2009

Company Background and Project Overview

Myers containers LLC is a steel drum manufacturer based in Portland, OR. Myers Containers began as Myers barrels in 1917 and has been in operation ever since under a few different owners. On October 11, 2007 Myers Container was acquired by the Stavig family and manufactures new steel drums at two facilities in Oregon and California under the name of Myers Container LLC. Myers Containers is also part of a joint venture with Container Management Services LLC (CMS). CMS reconditions intermediate bulk containers (IBC's), steel drums, and plastics drums. In the Portland area Myers containers has two facilities located just a few blocks from each other this gave us a unique opportunity to visit both facilities.

The first facility we visited was where the steel drums are manufactured as well as where the corporate headquarters are located. It was here that we first got an idea of how their fabrication process works. Sheet metal is brought in, then it is shaped into a hollow cylinder with two open ends. The shaped metal is then welded, and the barrel begins to take shape. It is worth noting that this is the only weld on the barrel, the reason for this is to minimize potential quality control issues, as well as minimizing costs, because welding on a line process is very expensive. Next the metal is stretched to maximize the volume of the drum and minimizing the amount of sheet metal used to create the drum. This is a very important because the sheet metal is purchased by weight so it is of the utmost importance to use it as efficiently as possible. The next phase of fabrication involves attaching a bottom to the drum, and a pre-specified top, depending on what the drum will be containing. At this point the drum is tested by pumping air directly into the barrel and making sure it is sealed properly. Every drum is tested like this, and one barrel out of every batch is pulled off the line and cut open, as a quality control measure. The next part of the process is extremely important to the end consumers of the drums. This process is the painting process in which the drums are heated, so the paint will properly adhere to the drum, then painted, and left to dry. Companies who order the drums are very strict as far as being exactly the right color, as well as, near perfect paint application, meaning no small air bubbles, or missed spots. To further our understanding of Myers Containers processes we needed to visit

the other facility which deals with the other part of Myers Containers, Container Management Services.

The CMS facility is where Intermediate Bulk Containers (IBC's) are cleaned out and refurbished. After they are cleaned and refurbished they are then sent back out to customers. This facility is also where CMS trucks in industrial plastics to be recycled. All the plastic that can be recycled is shredded up and sent to local plastic recyclers. The plastic that cannot be recycled is also shredded up, lightly packaged and shipped to China, where it will be used in another fashion. The process at this facility is much simpler seeming, but with all the various amounts of different types of remnants left in the IBC's all the liquids and gels are stored and treated, and this is very expensive, but necessary to minimize potential hazards to the environment. Although these tours were not directly related to the problem we were attempting to solve for Myers and CMS it was very informative and good background knowledge for our group moving forward with the project.

Currently Myers Containers and CMS have outsourced their logistics to a company named Pathfinder. This allows Myers to focus more on the operations at their facility and not worry about all the details of various logistical operations and record keeping. What Myers Containers wanted from us was to review their freight data and try and come up with no more than five key process indicators (KPI's). Because this information was so new to the various managers at Myers, meaning they requested the freight data from Pathfinder, they had not looked at it at all. It was our task to review the data and see if we noticed any patterns or anything of interest, to go along with the five KPI's. The information we analyzed was the freight data, which consisted of over six hundred entries that included order date, number of barrels ordered, estimated delivery date, and actual delivery date. We also requested the invoice data, so we could begin to match up the freight data, with the invoice data. The first thing we noticed was a group of customers known as the 360 group. These were companies who would take large amounts of containers on a regular basis. Pretty much, this group would take any number of containers shipped to them, meaning that these companies had large enough demand that Myers is able to ship drums to them on a perpetual basis. This led us to our first KPI, which in turn led to our group highlighting two more for a total of three KPI's.

The three KPI's we were able to discern from the data provided are the following: Quantities meeting the 360 fulfillment, Orders processed in a single day, Orders that missed either their pick or delivery date. The first indicates which trucks did or did not meet a shipping quantity of at least 360 for specific customers. The other two relate to customer service, the orders processed in a single day should be capitalized upon. Instructing the customers on how they

can take advantage of this service could prove to be very beneficial. For example if, in order to complete the process, the customer needs to place their order prior to a certain time, letting the customer know will ensure that more orders are fulfilled in just one day. The missed dates need to be looked into to improve customer service as well. To ensure customer satisfaction we need to be confident of our ETA's, or at the very least know why we are missing these dates. We will then move along to discuss each KPI in a bit more detail:

KPI: Missed Revenue

*Customers that have the capacity to accept 360 drums every time a truck is sent.

*Found occurrences where shipments were below the quota

*Matched freight data (where possible) to the invoice statements

*Found Dollars per drum, and calculated missed revenue

* Multiplied Dollars per drum by difference to find missed revenue

KPI: Single Day Turn Around

- From Pathfinder found customers that were consistently served in one day
- 4 relevant days, Requested Pickup, Actual Pickup, Delivery ETA & Actual Delivery
- Ensure consistency and Better Customer Service

Looked at all the data, performed an if function that returned the value 1 for all the same day shipments. Value of 0 for ones that took longer, this is how we found single day turnaround.

Missed Dates

- Discerned how many returns and deliveries had Differing ETA's to actual dates.
- Better Customer Service
- Track efficiency of Pathfinder

How we did this was to perform a few if functions. Basically stating if the ETA's differed from the actual return a value of 1, if they were the same return 0. This was done to be able to sum the number of shipments that had missed their estimated times.

Recommendations for increased data capture:

The number one recommendation of our group is to simply ask Pathfinder to collect a little more data in regards to returns, mileage traveled, and trailer information, numbers, and an area for

comments that might include when the ideal delivery time would be, this could be used in route planning too, for companies not on the 360 list.

From the distance traveled you can get a KPI for Drum Dollars per Mile. This can help compare shipping charges between different customers. The main thing we would want Myers to be able to calculate is profit margin per mile, based on information that Pathfinder can start providing. This can help indicate if there are more profitable regions/distances to ship Myers' products to. More importantly it can track the pathfinders' charges over time. It will be able to show the moment that your rates begin to fluctuate. This can allow management to change prices, or make changed in how they want to ship. We would also request that Pathfinder gives both shipping and invoice information in a similar manner. Either both sorted by customer or date. This will increase the ease of data analysis, this a reasonable request and should not be a problem for a third party logistics company. It would be very helpful if return, refurbishments, and Shipments can be reported separately. This will allow you to check for trends in each of these sections easily. Also this will enable you to more readily track the costs for each of these different types. Then you can compare rates of cost dollars per drum almost instantly. This will show if there is a certain type of service that you provide that is consistently more costly.

Through the analysis of the freight data and invoices sent to our consulting team, we were able to identify three key indicator processes. These processes were missed revenue, which was based off the 360 list, as well as single day turnarounds, and finally missed dates, based on ETA's provided on freight data sheet. This was a very interesting project that gave our group a chance to deal with real business and the issues that arise when doing business. We really enjoyed the freedom of that this project provided, and showed us that "real" business problems do not always have a specific answer or a specific way to go about solving the problem. Our only hope is that Myers Containers found the work we provided valuable.

Greening Procurement of Office Supplies at Northwest Natural

MBA Team: Bob Cherney, Danielle Isidore Harry, Maria Dossin, Brandon Hern

Industry Sponsor: Bill Edmonds, Director of Environmental Policy and Sustainability; Holly Meyer

Faculty Adviser: Nagesh N. Murthy

DSC 577, Spring 2009

Executive Summary

Northwest Natural (NWN) is a prominent natural gas distributor in the northwest that has shown a passion for sustainability in all of its operations. Because of these core values it is natural that the company would demand their suppliers also have a passion for sustainability. This is why the company has tasked this team with evaluating potential suppliers.

The Report This report takes the reader through the steps this team took to recommend a supplier to NWN. It first summarizes the scorecard that is used to evaluate the three office suppliers as well as explains the work done to get there. The three major components of this report are as follows:

1. The **scorecard** is the focus of this report. This scorecard includes items such as how sustainable is the suppliers transportation model, how many sustainable products the company offers, and how they measure their sustainable practices.
2. An **explanation of the methodology for the scorecard** follows the scorecard. This is designed to explain how and why we chose the criteria we did and why each company was rated in the manner it was rated.
3. Based on the scorecard we have made **a recommendation to NWN as to which company to contract with**. This recommendation will include a detailed account of information learned about each supplier. The detailed account shows things that the scorecard cannot by taking a more qualitative approach to documenting the sustainability of each company.

Project Overview & Scope

Northwest Natural (NWN) has tasked our team with evaluating three suppliers of office products on the basis of their sustainability. NWN values sustainable business practices, and they believe that their office product supplier should exhibit those same values. NWN's intent with this project is to have a thorough third party assessment of the three (30 suppliers in the sustainability realm. Throughout this project we have evaluated Office Max, Office Depot and Staples, as these are the companies NWN will be considering in their bidding process. These companies are leaders in the office supply business and all report efforts to be sustainable. Though cost is an important factor in NWN's decision-making process, the scope of our project will not focus on that factor. NWN intends on taking the findings from our research and judge it against their costing structure before they decided on any office supplier. The cost differential between each of the office suppliers will only partially influence their final decision. NWN understands, and realizes, that there may be an additional cost incurred to the company through following these actions.

Evaluation Methodology: When evaluating the three office supply companies on their sustainability efforts, we focused primarily on transparency, tracking and monitoring capabilities, passion for sustainability, and, most importantly, where the company is today in their efforts to be sustainable. Looking at evaluating sustainability, we took a number of factors into consideration. In an attempt to link our evaluation with the vision and intent of NWN, we divided our criteria into two general categories: An overall Company Profile and the extent of the Green Product Line offered. The Company Profile includes criteria such as the given companies transportation methods, packaging methods, and infrastructure awareness. While we understand that evaluating each company in these realms is a task in itself, we feel that the availability of this information and transparency of a given company is an important tenant in sustainability. Below are the exact categories in which we focused our research and valuation in:

See Company Profile
Transportation Methods
Use of alternative fuels
Use of Hybrids
Packaging methods
One use, individual packaging
Combined totes

Reuse, multiple use shipping containers
Infrastructure awareness
Renewable energy usage
Renewable energy credits
LEED certification
Purchasing controls and ease of use
Passion for sustainability
Global Reporting Index (GRI)
Supplier requirements
Energy use/efficiency awareness
Recycling at work program
Other

Greening Procurement of Custodial Supplies at Northwest Natural

MBA Team: Li Feng, Kevin Johnson, Justin Overdevest, Dan Tremblay

Industry Sponsor: Bill Edmonds, Director of Environmental Policy and Sustainability; Holly Meyer

Faculty Adviser: Nagesh N. Murthy

DSC 577, Spring 2009

Executive Summary

Northwest Natural (NWN) is committed to environmental excellence and has the ongoing goal of implementing sustainability practices. Northwest Natural partnered with the University of Oregon to conduct an analysis of green cleaning products in order to improve this aspect of their procurement and supply chain processes.

ProblemNWN wants to adopt green cleaning processes in its 12 Field Offices. Sometime this summer NWN will be going to bid for a janitorial service contract and in that process will need to convey a desired product manufacturer or guidelines that cover green cleaning supplies. NWN has determined that the following factors are important to the purchase of green cleaning supplies:

- Cost reduction
- Minimized environmental impacts across full product lifecycle
- Consumption of fewer natural resources
- Pollution and toxic material prevention
- Elimination of human health risks
- Demonstration of NWN corporate social responsibility

Solution Methodology

The main steps taken to conduct the analysis of the most appropriate green cleaning supplier included: (1) Research and benchmark decision factors (2) Establish decision matrix (3) Compile interviews and case studies (4) Recommendation (5) Articulate next steps and develop contract language for upcoming bid.

Rationale for Recommended Solution

Coastwide Laboratories is the best source of green cleaning supplies for NW Natural.

Coastwide's line of Sustainable Earth products fits the criteria of human health, environmental impacts, third party certification, product performance, as well as price. Coastwide's nationwide industry leadership is tied directly to a greener supply chain and leaner product life cycle.

Because NW Natural is an Oregon based company with a 150-year history it should attempt to purchase from a local vendor and Coastwide is the only local vendor that offers the product line breadth that NWN requires. Coastwide utilizes a "stockless" ordering system that acts as a just in-time system that allows customers to save money on ordering costs. Coastwide also provides education on how to use their products to maximize economic and functional performance.

Additionally, regional manufacturing in Salem and the use of alternative fuels for transportation (biodiesel from the safflower oil output from Kettle Foods) make Coastwide's supply chain stand out in comparison to its competitors. Case studies, particularly TriMet highlight the bundle of benefits that Coastwide and its Sustainable Earth products offer its customers. Beyond the main decision factors for procurement, Coastwide's innovative product development and promotion of green cleaning supplies, offers a regionally based company, such as NW Natural the best product offering.

INTRODUCTION

The terms *green* and *sustainable* are often used without a clear definition and can be an impediment in the procurement process. "Greenspeak" creates a language that fails to communicate how a product or service performs under guidelines that bridge economics, the environment, and social concerns. We developed a series of product criteria to allow for a more informed decision of the procurement process that met the highest bar for use at Northwest Natural. The Environmental Protection Agency, Green Seal, and many different companies involved in the production and distribution of cleaning supplies have contributed much to the field of green cleaning products. Ideally, the evaluation of a product's ability to meet criteria for human health, price, performance, and environmental impact will be encompassed in any application of third party certification schemes. The goal of this paper is to guide the reader through some of the difficult issues surrounding the topics of green cleaning criteria, industry standards, and supply-chain options.

PROJECT SCOPE

Objective: Support NW Natural's (NWN) green purchasing efforts by developing recommendations for office and custodial supplies procurement.

Background: NWN has made a corporate commitment to sustainability throughout its operations. Amidst these efforts, the company has also made a major commitment to "green" its purchasing practices. One major area that has been highlighted for additional work is custodial supplies. The goal of this project is to perform a comparative analysis of the options NW Natural has for custodial supplies, make a recommendation to senior management, and develop criteria and processes by which employees will be steered towards and incented to make greener purchasing decisions.

PROCUREMENT DECISION FACTORS

Certification Overview- A number of second and third party certifications exist, including:

- Design for Environment (DfE) certification is the most rigorous certification process. Companies are not required to pay for the certification process.
- Green Seal is a third party certification well known for its product certification. However, Green Seal does create a barrier to product certification with high membership and annual fees *per product*, \$7500 and \$5,000, respectively.
- Eco Logo is a Canadian organization that assesses and certifies green cleaning products and is similar in operation to Green Seal. These certified products provide comparable or superior performance to conventional products.

Environmental Protection Agency's Design for the Environment

The EPA's Five Guiding Principles of Procurement are:

- Environment + Price + Performance = Environmentally Preferable Purchasing
- Pollution Prevention
- Life Cycle Perspective/Multiple Attributes
- Comparison of Environmental Impacts
- Environmental Performance Information.

Design for the Environment (DfE) is a program run by the U.S. Environmental Protection Agency (EPA). The aspect of the program that relates to janitorial supplies is the Safer Formulations Program; specifically the Industrial/Institutional Cleaning Partnership. To earn certification, vendors submit their products to the EPA to be screened for a variety of pollutants

and toxic ingredients. One of DfE's draws is that there is no fee to have your products certified. The producer must become a partner of the DfE Program, but partnership is part of what proves certification. After signing the partnership agreement, the producer submits their products to be screened and verified. DfE product screening is rigorous and complete.

Green Seal: Standards and Certification

Green Seal is an independent non-profit, third party certifier and standards development body in the United States. Their purpose is safeguarding the environment and transforming the marketplace by promoting the manufacture, purchase, and use of environmentally responsible products and services. Green Seal is the largest US-based eco-labeling organization and meets the United States Environmental Protection Agency's Criteria for Third Party Certifiers, the requirements of ISO 14020 and 14024, and the standards of the Global Eco-labeling Network. Green Seal has its own Environmental Standards listed in the following categories: Design for the Environment. 2009. Accessed May 15, 2009. <http://www.epa.gov/dfe/pubs/about/index.htm>

http://www.epa.gov/dfe/pubs/formulat/draft_boilerplate_partnership_agreement

[%20_cleaning_products_website.pdf](#)

<http://www.greenseal.org/>

- Construction materials, equipment and systems
- Facility operations, maintenance and services
- Hospitality, lodging and food service
- Home products and services
- Office products and communications
- Personal care and consumer packaged goods
- Transportation and utilities.

For each category, Green Seal has its specific standards of being environmental friendly. For a company to get its products certified, it has to follow the certification process which can be found on www.greenseal.org website. The detailed standards, application process, and fee information are posted as reference. A Green Seal Certification Mark on a product means that it has gone through a stringent process to show that it has less impact on the environment and human health. Green Seal takes a life cycle assessment approach, evaluating a product from the raw materials through the manufacturing process and ending with recycling or disposal. Products only become certified after a rigorous science-based evaluation, which includes on-site plant visits. The Green Seal means that the product has passed the tests; that it works

as well as or better than others in its class, and that it has been evaluated without bias or conflict of interest.

Occupational Safety and Health Administration (OSHA)

OSHA's Material Safety Data Sheets (MSDS) include information that is important in discerning if a product is healthy to use. OSHA has established the following list of chemicals to avoid: Alkylphenol ethoxylates, Butoxyethanol, Dibutyl phthalate, Hydrochloric Acid, Phosphoric Acid, Sodium Hydroxide, heavy metals (e.g. arsenic, lead, cadmium), corrosive or flammable, bioaccumulative pollutants, carcinogenic materials. The Toxic Use Release Inventory (TURI) allows users to determine chemical impact and releases by simply typing in the product ingredients into its online database to ascertain the danger associated with the chemicals in question. Vendors are required by OSHA to provide MSDS sheets customers/workers using potentially harmful chemicals in the workplace. OSHA and the Superfund Amendments and Reauthorization Act (SARA) require a vendor of cleaning products
<http://www.green Seal.org/>

Toxic Use Reduction Inventory, http://www.turi.org/laboratory/cleanersolutions_database/database_previews/find_a_cleaner
http://www.cleanersolutions.org/?action=contaminant_search to disclose each chemical used on the MSDS individual chemical list. Health Hazard Ratings are as follows: 0=insignificant, 1= slight, 2= moderate, 3=high, 4= extreme.

Products with the lowest ratings should be chosen. Additional attributes included on the MSDS form and product labels include: toxicity, volatile organic compounds (VOCs), pH levels between 2.5 and 12, reduced or no added dyes, reduced or no added fragrances, and reduced or no added skin irritants. An MSDS contains the following sections7: (1) Chemical Product and Company Identification; (2) Composition/ Information on Ingredients; (3) Hazards Identification; (4) First Aid Measures; (5) Fire Fighting Measures; (6) Accidental Release Measures; (7) Handling and Storage; (8) Exposure Controls/ Personal Protection; (9) Physical and Chemical Properties; (10) Stability and Reactivity (11) Toxicological Information; (12) Ecological Information; (13) Disposal Considerations; (14) Transportation Information; (15) Regulatory Information; (16) Other Information OSHA's Hazard Communication Standard (HCS) dictates the content and distribution of information on chemicals used in the workplace. Within this framework, the MSDS provides a standardized and accessible source of information for businesses and their employees. The requirements of HCS cover any occupational use of a chemical or toxic substance. Occupational use is defined as routine exposure associated with required work functions. The HCS contains a consumer products exemption that applies to

products used in a manner “with the frequency and duration as that of a normal [non-occupational] consumer.”

Additional Considerations for Supply Purchase:

The Leadership in Energy and Environmental Design (LEED) certification for existing buildings (LEED-EB) has structured 8 out of the 28 points for the use of sustainable cleaning products. The products used determine points but also by functions of prevention of cleaning i.e. having grills, mats, or water spigots outside of the building to decrease the amount of cleaning needed. A preventive approach is important especially in the case of NW Natural as the winter months develop messy conditions for field crews. Waste reduction by using cloth towels or recycled paper products is also considered favorable based on the LEED-EB certification.

Environmental Protection Agency. Publication on Cleaning Product Procurement. 2009. <http://www.epa.gov/epp/pubs/products/cleaning.htm>
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=101
http://www.osha.gov/pls/oshaweb/owadisp.show_document?

U.S. Green Building Council <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1762>

Supply Chain Optimization Project at YAKIMA

MBA Team: Susan Einberger, Colin Geartiy, Eugene Gonzales, Brooke Standifer, Ben West

Industry Sponsor: Mike Steck, Senior Director, Customer Marketing and Sustainability; Josh Creasman, Director of Supply Chain

Faculty Adviser: Nagesh N. Murthy

DSC 577, Spring 2009

Executive Summary

Yakima, a premier manufacturer of “destination hardware”, would like to determine the optimal location for a third distribution center. The company’s current supply chain includes manufacturing facilities in Mexico and China, and distribution centers in Riverside, CA and Memphis, Tennessee. After manufacturing, all products arrive in Riverside for shipments to the Memphis distribution center and/or customers. Once in the United States, inbound shipments are primarily sent via rail and outbound shipments are primarily sent via less-than-load (LTL) trucks or packaged carriers, such as FedEx. The team analyzed a year’s worth of LTL and FedEx data provided by Yakima to determine the optimal location for a third distribution center.

The purpose of the third distribution center is for Yakima to be able to service its customers in the Northeast in two days or less. Using the outbound delivery time as the most important criteria, we identified three possible locations (for the new distribution center) that are major rail hubs and offer the least cost opportunity. The three locations include Buffalo, NY, Harrisburg, PA, and Trenton, NJ; further analysis including factors like national cost of living indices resulted in Trenton, NJ being the optimal location. The team recommends that Yakima use this research as a base for further analysis and strongly consider locating its new distribution center in Trenton, NJ.

Problem Statement Yakima products are manufactured in Mexico and China, transported to distribution centers (D.C.) in Riverside, California and Memphis, Tennessee, and then delivered to customers around the country. Customers are serviced by either truckload (TL), less than truckload (LTL), or smaller shipments handled by packaged carriers like FedEx. Yakima is looking to add a third distribution center to its supply chain in order to better serve its customers in the Northeast. *The company would like to know where the optimal location for a third distribution center is so customers in upper Northeast can be serviced in at least two days time by FedEx Ground Transportation.*

In this case, *optimal*, will be the distribution center location that:

- Minimizes inbound and outbound shipping costs
- Services customers in the upper Northeast in two days or less
- Resides in a location where space in a current warehouse/distribution center can be leased
- Minimizes operational costs
- Near a major rail hub
- Geographically, the distribution center must be further North and East than Memphis.

Analysis to Establish 3 Cities as Potential Sites:

1. Outline the market in the Northeast that the new D.C. would service and locate potential states that the D.C. could be located in:

- Based on a year's worth of data for FedEx shipments out of the Memphis D.C., Yakima is spending the most money and shipping the most weight to the following Northeast states: New York, Pennsylvania, Michigan, North Carolina, Wisconsin, and Virginia respectively (see Appendix A)
- Based on data for LTL shipments out of the Memphis D.C., Yakima is spending the most money to ship to the following Northeast states: Vermont, Massachusetts, Pennsylvania, New York, and Virginia (see Appendix B)
- Logically, if Yakima locates the third distribution center in one of the regions where it spends the most shipping from Memphis, the company will realize the most savings on outbound shipments
- We eliminated Michigan, North Carolina, and Wisconsin as potential D.C. locations because outbound shipments won't reach the Northeast in less than two days based off of sample locations using FedEx maps
- Therefore, the remaining potential states are New York, Pennsylvania, and Virginia.

2. Once the three states were established we needed to figure out where, within the states, it would be optimal to place a D.C.:

- We drilled down further on data from the three states to identify the two-digit zip codes within each of these three states that Yakima is spending the most to ship to from Memphis (see Appendix C)
- Once we located the two-digit zip code areas using the FedEx data, we then compared it to the LTL Volume Shipment map (see attached map "LTL Volume Shipment Count") to draw any parallels between the major areas and then identified cities that corresponded to those areas
- We then used the FedEx software to see if the cities identified in the previous step would service all of the Northeast in two days or less

- The result was a list of six cities that could be potential sites for the new D.C. The next step was contacting CH Robinson to identify cities with major rail hubs to ensure the inbound side of the supply chain was also time and cost effective
- After our analysis and discussion with CH Robinson, it was recommended that we stop looking at Virginia and use Trenton, NJ as a possible site instead
- Based on the analysis and secondary research, we determined the following three cities and their corresponding zip codes were good starting points and warranted further analysis:
 - o Buffalo, NY (14206)
 - o Harrisburg, PA (17101)
 - o Trenton, NJ (08619)

Analysis after Establishing 3 Sites:

- After establishing the three potential locations we developed a set of core states that can be serviced within 2 days. Those states are: ME, VT, NH, MA, CT, NY, NJ, DE, MD, PA, RI, and VA
- We also established a set of outlier states that would compare the cost of FedEx and LTL shipment costs between the new potential D.C. site and the Memphis D.C. site. The following states were chosen: IN, MI, NC, OH, and WV
- We then used the data submitted to the team by Yakima and created a pivot table that broke out the data by state, by 3-digit zip, by average weight, and by cost. From this compilation, we picked the top two ship-to cities in the core and outlier states to use as proxies for their respective state to estimate the cost of outbound shipping from the three potential D.C. locations (see appendix D)
- We proceeded by calculating the FedEx and LTL shipment costs (to the cities identified in the previous step) using the FedEx website and Czarlite for the three potential D.C.s. We compared the estimated costs from the new D.C. locations to the actual cost of FedEx and LTL shipment costs from the Memphis D.C. (see Appendix E for calculated shipping costs from the FedEx website and see Appendix F for the sample amounts used to calculate LTL shipment costs using Czarlite)

Results and Recommendations

Outbound Costs

- Outbound costs for Yakima are split between package shipments with FedEx and LTL shipments with CH Robinson. As mentioned before, we ran the core 12 states (ME, VT, NH, MA, CT, NY, NJ, DE, MD, PA, RI, VA) and five outlier states (IN, MI, NC, OH, WV) through the two most popular destination cities for each outbound shipping type to get a reasonable assessment of what cost savings could be expected by locating a 3rd D.C. in the Northeast US (Harrisburg, PA, Trenton, NJ, and Buffalo, NY).
- The FedEx data delivered a savings at each of the 24 core start delivery locations, except for one delivery into Rhode Island, and provided a cost equal to, or less than, Memphis for the 10 outlier delivery locations (see Appendix E)
- When these spot checks are extrapolated across the 12 core states and the five outlier states for the calendar year, assuming that all delivery locations in the core and outlier states represent a similar savings to the spot check cities, a savings of \$6,000 - \$7,400 can be taken for the core area and \$250 - \$450 can be taken for the outlier area on an annual basis (see Appendix G).
- Similar analysis was carried out for LTL shipments. However, not as many core and outlier states offered a cost savings when compared to FedEx shipments. In fact 10 of the 24 core delivery areas were more expensive with the proposed D.C. origins in the Northeast vs. from the current D.C. in Memphis, TN. Of the outlier delivery areas, only three of 10 delivery locations offered a cost savings with their proposed D.C. origin in the Northeast vs. from the current D.C. in Memphis, TN (see Appendix H).
- With this information, we eliminated VA from the core delivery area and will leave package and LTL delivery to VA from Memphis, TN. However, only one state (MI) within the outlier states offered a good cost savings; therefore it will be included in the delivery zone for the new Northeast D.C. and is included in total cost outbound cost saving calculations.
- When these spot checks are extrapolated across the 12 core states and the five outlier states for the calendar year, assuming that all delivery locations in the core and outlier states represent a similar savings to the spot check cities, a savings of \$42,000 - \$75,00 can be taken for the core area and -\$2,000 - \$13,000 can be taken for the outlier area on an annual basis (see Appendix I).

**Appendix A3: Sponsored Projects in Supply Chain Management Elective offered
for Undergraduates and MBAs: DSC 477/577, Spring 2010**

**Field-Based Experiential Learning Projects Undertaken Under the Auspices of
OEI-DLA-DoD 2009 Initiative**

**Sponsored Projects in Supply Chain Management Elective offered for
Undergraduates and MBAs: DSC 477/577, Spring 2010**

Faculty Adviser: Nagesh N. Murthy

The projects have been listed below. Confidentiality agreements were signed with sponsoring companies to elicit all the data required for these problem solving projects. The Principal Investigator has all the final reports submitted by the teams. Excerpts from these reports have been provided to provide a reasonable view of these projects without violating confidentiality issues. Some of these reports have been converted from PDF files to a Word document resulting in loss of some formatting. The Principal Investigator would be glad to furnish the reports if needed for audit, but did not deem it to be appropriate to put the entire report in public domain.

Commodity Costing Project at Monaco RV

UG Team: Dareus Robinson, Bondy Black and Brad Hoeren

Industry Sponsor: Dennis Girod, Purchasing Manager

Freight Optimization Project at Myers Container

UG Team: Vanessa Sin, Raymond Santosa, Jesse Denham, and Sean Loud.

Industry Sponsor: Taylor Gordon, System Analyst

EWEB Warehouse Relocation Project

MBA team: Greg Carlson, Jia Hu, Jaxon Love, Erin Malone, and Hendrik Van Hemert

Industry Sponsor: Keith Engel, Lile Moving and Storage; Rick Motley, Warehouse Manager, EWEB

Warehouse Design for Inbound Materials at Monaco RV

UG Team: Malia Harada, Alexi Wilson, Drew Kroeplin, and Scott Fogel

Industry Sponsor: Dennis Girod, Purchasing Manager

Organically Grown Company Product Coding Project

MBA Team: Doug Anderson, Katie Brennan, Paul Clark, Kelly McKeag, and Dan Simon

Industry sponsor: Josh Hinerfeld, CEO; Jason Smith; Waylon Spoden; Robbie Vasilinda

Supply Chain Management Project at StoveTec

MBA Team: Brett Ratchford, Tracy Reyes, Linda Anson, and Mohammad Rashid Rasool

Industry Sponsor: Ben West, General Manager; Miles Makdisi, Office Manager

Inventory management System Analysis II at Myers Container

UG Team: Greg Zimet, Luke Leon, Katelyn Sanders, and Eric Eszlinger

Industry Sponsor: Taylor Gordon, System Analyst

Commodity Costing Project at Monaco RV

UG Team: Dareus Robinson, Bondy Black and Brad Hoeren

Industry Sponsor: Dennis Girod, Purchasing Manager

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2010

Executive Summary

After the purchase then Monaco Coach by Navistar International Corporation, it was necessary for Monaco RV to comply with Navistar's cost-cutting measures, most importantly, commodity costing. However, Monaco RV's existing system is unable to quickly and easily assess total quantities of raw materials per model. This is mainly due to no distinction between commodity inputs and pre-fabricated parts in the bill of materials.

The goal of this project is to create an adaptable system for valuing and determining the weights of each commodity per RV. After trial and error, we were able to develop our manual sorting system into an automated process. Some of the problems we encountered include: distinguishing which parts qualify as raw materials, determining the dimensions of items, and differentiating items with similar prefixes. We wrote a compound "If" function that labels all commodity inputs as their material composition, searches the composition, and calculates the weight of each item.

From here on out, we recommend that Monaco RV standardize its descriptions of items in the bill of materials adding individual columns for each dimension and material type.

These recommendations will have barriers to implementation and will require time to convert people and processes into the new system. However, Monaco RV is in a transitional phase and stressing the importance of refining information accessed for daily use will help to mitigate these barriers

Background & Context

In 2009, Navistar International Corporation purchased the assets of Monaco RV and brought it into the Navistar family. Navistar uses many cost-reducing practices that Monaco RV previously lacked. Navistar's commodity valuation and cost-forecasting is the most important

practice regarding this project. Currently, assemblies are listed with components which make up each unit.

The complete list of the assemblies (the bill of materials or BOM), is comprised of information detailing each part of the RV. The BOM for the Endeavor model is 3170 rows, each representing a part or assembly and having over 100 attribute columns. Several of these columns are mostly or entirely blank. Also, many columns show identical data for each row. In general, there is an overwhelming amount of data contained in Monaco RV's BOMs, most is unnecessary and/or redundant. Despite this excess, many valuable pieces of information are absent from these BOMs.

Problem Scope

The major problem with Monaco RV's existing system is that the total amount of each commodity (for example aluminum) used in a model is not easily attainable. Its system is incapable of quickly and easily assessing the total quantity of raw materials that are used in a specific RV model. This is mainly due to no distinction between commodity inputs and pre-fabricated parts in the BOM.

The current form for each BOM document is designed for the production of the coaches. While manufacturing is the primary concern for Monaco RV, the form does not account for which components should be valued as raw materials.

Key Project Objectives

The overall goal of this project is to allow the BOM to account for commodity based components. To reach this goal, two objectives must be met. These include:

1. To create an adaptable system for valuing commodities
2. Determining the weights of each commodity per RV

System Creation

The main focus of our efforts was toward the creation of a system capable of meeting the current needs of Monaco RV while also being flexible enough to function with any model that Monaco RV might make.

Weight Determination

There are two reasons for this objective. One, it is an effective test of our systems' functionality and two; this information was requested by our contact and is immediately valuable.

Solution Methodology

We started by manually sifting through the Endeavor model's BOM to extract those SKUs which likely were commodity inputs. We sorted product descriptions alphabetically to simplify the process. Then, each of us looked at roughly 1000 items and highlighted potential commodities. Next, we manually categorized these highlighted items according to their material composition. The resulting spreadsheet was both aesthetically awful and not very useful on its own, but did help us to choose keywords that were present in the vast majority of commodity SKUs. This step also emphasized that having 100+ attributes per row in a single spreadsheet was more detrimental than beneficial.

By taking the lessons gathered from our manual sorting we worked to automate the process. We saw several options for achieving this, which will be discussed later. We chose the best option for the short-term but agreed that a better long-term solution exists.

The option we are recommending for the short-term uses the current BOM workbook and the logical functionality of Excel. We wrote a compound "If" function that reads each description and labels all commodity inputs as their material composition in one column. The next part of our solution is a set of columns, one for each commodity category. Each of these searches the new material composition column and pulls the information for a single commodity, calculating the weight of each line item. Looking at each of these columns can be tedious to determine the total weight or cost of a specific raw material in each model. Therefore, there is a final sheet which compiles the total weight of each commodity based component.

Currently, some parts are labeled as "EA" (each) as a unit of measure. Our team was asked to try to convert some of these so components would be shown by length foot measurement. The value of this conversion is that it allows Monaco RV to easily total the number or feet of a particular component, such as wire, that are used in each RV. The current system would require manually taking the length of a component and multiplying it by the amount used.

For our solutions we assumed that the last dimension listed in a description represented the length of that item. We also assumed that for items originally listed as having "EA" as a unit of

measurement, the quantity column displayed the percentage of a full piece used. Lastly, we assumed that aluminum pieces have SKUs between 600000 and 700000.

This solution also required much information that we did not have at the outset; however, through Dennis we were able to acquire almost all of the data we sought. Specifically, we needed the weight of each item or the weight of a material given a set of dimensions.

Freight Optimization Project at Myers Container

UG Team: Vanessa Sin, Raymond Santosa, Jesse Denham, and Sean Loud.

Industry Sponsor: Taylor Gordon, System Analyst

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2010

Executive Summary

Background

Myers Container's (MC) Killingsworth facility makes highly customizable metal drums. Because of this customization, MC can't produce drums in advance. Almost all production is made-to-order. The only exception is for companies that place the same order frequently. Due to lack of space, very low levels of inventory are kept at the Killingsworth facility. This inventory is not well tracked and future needs are not forecast. MC incurs a lot of transportation cost making last minute supply orders to rush-fill inventory in order to meet customer deadlines. PathFinder logistics (PF) manages all of MC's Chicago freight. They schedule pickups and shipments and bill MC for the freight charges.

Objective

Our goal is to find the largest cost drivers for MC shipments from Chicago to the Killingsworth facility in Portland.

Solution Methodology

Using purchase order data from MC and shipping data from PF, we will analyze the cost differences between different shipping methods. From this, we can extrapolate the possible cost savings by reducing costly less-than-truckload shipments.

Analysis

Average shipping costs come to \$0.09 per pound for intermodal (IM) shipments and \$0.31 per pound for less-than-truckload (LTL). It also estimated that 50% of total shipments are IM and the other 50% are LTL. On average, there are roughly 3 shipments per month, 36 per year. On average per shipment, LTL transports 5,153 pounds and IM transports 21,570 pounds. Using these numbers, LTL and IM shipments cost \$28,754 and \$34,943 per year, respectively. This comes to a yearly shipping cost of \$63,697 for parts from Chicago to Portland.

Manipulating the number of each shipment per year, we find that about \$10,000 can be saved by reducing LTL's by 10 shipments per year and \$20,000 by reducing LTL's to 0.

Possible Further Analysis

We would like to further analyze our data to make better comparisons between LTL and IM shipments as well as holding costs vs. transportation cost. However, in order to do so, data tracking needs to be improved to include more items that are tracked more accurately. Shipping data needs accurate dates for when an order was made and completed, shipped and delivered, along with the invoice date. In order to determine accurate shipping costs for parts, it is important to know exactly which parts are in which shipments. Attaching POs to individual shipment data would allow for easy tracking of when and how things were shipped. POs also need consistently entered data. Some prices seem to be entered as a lump sum, while others are per item.

Background and Problem

Myers Container's (MC) Killingsworth facility makes highly customizable metal drums. These can be customized in many different ways:

- sizes (35 gal, 55 gal, etc)
- lids and pour spouts
- metal thicknesses (for lids and drum)
- exterior paint
- interior lining (many different paint on linings depending on what the drum will contain).

Because of this customization, MC can't produce drums in advance. Almost everything is made-to-order. The only exception is for companies that make the same order frequently (every month or couple months). When MC has downtime, they will fill it by producing drums for one of these frequent orders.

Due to lack of space, very low levels of inventory are kept at the Killingsworth facility. This inventory is not well tracked and future needs are not forecast. New parts orders are only made when it is noticed that inventories are low. This often leads to a stock-out situation which can delay customer orders significantly.

MC incurs a high transportation cost when placing last minute supply orders to rush-fill inventory in order to meet customer deadlines. They know costs are incurred because of this however

they don't know what those costs are or why they exist. Our job is to identify these cost drivers and where they come from.

In order to narrow the scope, we will focus on costs incurred shipping from Chicago suppliers to the Killingsworth facility. Parts shipped from the four Chicago suppliers are consolidated at one supplier location (which supplier that is seems to be variable) before they are they picked up by the shipper. PathFinder logistics (PF) manages all of MC's Chicago freight. They schedule pickups and shipments and bill MC for the freight charges. Goods are shipped out of Chicago using a few different methods:

- Intermodal (IM) is used when time is not a factor – Parts are loaded into a shipping container. When full, that container is taken by truck to a rail-freight yard in Chicago and loaded onto a train. When the train has had enough freight added to make the trip worthwhile (this wait time is highly variable), it departs. When the freight arrives in Portland, the shipping container is picked up by a truck and dropped off at Killingsworth where the container can wait to be unloaded.
- Less-Than-Truckload (LTL) is used when a small amount of parts needs to be shipped quickly – Parts are loaded into a truck which PF will try to fill up with goods for MC and other companies. The truck leaves for Portland as soon as possible. When it arrives it is immediately unloaded. Costs for LTL are variable and depend on how well PF can fill the truck with goods from other companies.
- Truckload (TL) is used when a larger amount of parts needs to be shipped quickly – Very much like LTL, except that the truck only contains parts for MC. We could not get a good idea of these prices as we only had data for one TL shipment.

Objective

As we discussed in the background, Shipping from Chicago is expensive, especially when it is rushed via LTL or TL. MC is unsure what these costs are and would like a better idea in order to identify some cost saving opportunities. Our goal is to find the largest cost drivers for MC shipments from Chicago to the Killingsworth facility in Portland.

Solution Methodology

Our first approach is using PathFinder shipping data to find out what types of transportation MC uses as well as the total shipping costs and lead time for each transportation method they use. Next, we would like to know if we can connect the purchase data given by MC and the shipping

data from PF using Purchase Order ID. We want to extract information about the data's accuracy by matching the P.O. ID between the two companies, especially the Order Date, Ship Date and Invoice Date. Therefore, we will know the total lead times from asking suppliers for orders to arrive back in Myers Containers. The customer order is another piece of information we can extract. It is very important to determine how "on time" the transportation to satisfy inventory is in order to see the frequency of rush orders.

Furthermore, our assumptions from the data are that the invoice date from Myers Container represents the date suppliers are ready to send the orders to Myers Container. In addition, we assume the invoice date in Pathfinder's data is the delivered date, in which goods ordered arrive in the Killingsworth facility. From our solution methodology, we discovered interesting findings which are discussed below.

EWEB Warehouse Relocation Project

MBA team: Greg Carlson, Jia Hu, Jaxon Love, Erin Malone, and Hendrik Van Hemert

Industry Sponsor: Keith Engel, Project Manager, Lile Moving and Storage; Rick Motley, Warehouse Manager, EWEB

Faculty Adviser: Nagesh N. Murthy

DSC 577, Spring 2010

Executive Summary

Project Scope

In the fall of 2010, Eugene Water & Electric Board (EWEB) will relocate its warehouse from its current 4th Avenue location to a new facility on River Road, the Roosevelt Operations Center (ROC). This is part of a larger move of EWEB's entire headquarters. Currently, the warehouse holds over 3,500 Stock Keeping Units (SKUs) and hundreds of thousands of individual pieces of inventory. In order to streamline the move, EWEB has hired logistics expert Lile Moving & Storage to assist with the move. Together EWEB and Lile will spread the move over 9 days and utilize 12-15 staff members to complete the move. The scope of our project is to analyze the proposed process of warehouse relocation and offer an outside perspective into how to gain greater efficiencies throughout the move.

Proposed Plan

EWEB and Lile are planning the inventory transfer by focusing on the following objectives in regard to the move: tracking, efficiency and organization. The entire relocation plan is based on achieving these three objectives which, if achieved, will allow EWEB to maintain high service levels. Because it is critical for EWEB to remain responsive to its service territory and be prepared for any emergencies throughout the move, high service levels during this time are critical. As such, there are considerable trade-offs that will arise between logistical efficiency and responsiveness.

Methodology and Analysis

In this report, our team has included the following elements:

- ☐ A description of the current relocation plan as proposed by EWEB and Lile
- ☐ A critique of the current proposed relocation plan
- ☐ A discussion of warehouse relocation best practices

□□ Specific recommendations for the forthcoming EWEB warehouse move

Based on EWEB's primary objectives, our group created a framework to fully understand the scope of the problem and to develop relevant recommendations to better facilitate the move. We identified six critical aspects of the warehouse relocation around which we developed our recommendations to better facilitate the moving process. These six critical aspects are: sequencing, partial truck loads, critical inventory, in-transit tracking, human resources, and inventory management. In general, we have determined that the proposed plan is thorough. The suggestions and recommendations in this report should provide EWEB and Lile with guidance for making incremental improvements to the proposed plan.

EWEB Warehouse Relocation: Project Description

Rick Motley, Warehouse Manager at EWEB, and Keith Engel, Project Manager at Lile, met with our team on Thursday, April 15 for a facility tour and overview of the project. Lile Moving and Storage Company contracted with EWEB to manage the relocation of all warehouse and stockyard inventory from the current EWEB facility on 4th Avenue to a new storage facility on River Road. The new facility, known as the ROC, is slightly smaller than the current warehouse, but is custom designed to the needs of EWEB inventory management. Our team was charged with evaluating the current inventory transfer plans and suggesting methods that will improve the ability to track inventory as it is moved, reduce the time required to complete the move, and increase the level of organization during the implementation of the inventory transfer.

Project Scope

The scope of this project included all inventory held at the EWEB storage facility. This includes approximately 3,500 SKUs which range in size from a few milligrams to several tons (See Exhibit 1: Inventory at EWEB Facility). The team focused primarily on inventory that is stored inside the EWEB warehouse, but the team also considered inventory which is stored in the stockyard. We did not consider rolling stock (boom trucks, service vehicles, etc). We considered the logistical flow of physical goods beginning with movement from its current location, loading onto a flatbed moving truck, transportation to the new facility, unloading, and placement in its new location at the ROC. We analyzed the existing inventory database system and considered alternatives to the process that has been proposed for electronically tracking the transfer of SKUs.

Objectives

EWEB and Lile identified three primary objectives (in order of priority) for the inventory transfer:

1. Tracking – EWEB’s inventory management team must be able to locate every SKU during the transfer in a very short period of time (one hour or less). At the end of each day, inventory managers must be able to print a complete list with the location of each inventory item.
2. Efficiency – The transfer must be completed in no more than nine days. The move will begin on a weekend and finish the following weekend. The move must be completed in one business week and two weekends.
3. Organization – EWEB wishes to streamline the transfer by moving items in a systematic and logical manner. Transfer planning should provide details regarding the order in which items will be moved (i.e. which items should be moved first, second, third, etc).

Based on this prioritization of objectives, we developed a problem analysis framework organized into six categories. These categories, referred to as “critical aspects”, provide a systematic basis for classifying our suggestions and recommendations (see EWEB Warehouse Relocation: Six Critical Aspects). Given the absence of historical data for this type of move, we determined that logic and intuition would be the most appropriate evaluation methodology. Since the datasets for inventory location and quantity are either extremely large or incomplete and/or non-existent, we do not believe that a purely mathematical approach will be effective.

Proposed Solution: Description

EWEB will complete the relocation of its inventory from the 4th Avenue facility (origin) to the new ROC facility (destination) during October 2010. This move will take place over the course of nine days. The move will begin on a Saturday, continue through one entire work week (Monday through Friday), and conclude on Sunday of the following weekend. EWEB will dedicate between three and five employees to work on the move during the two weekends and three employees to work during the work week. Lile will have ten employees dedicated during the weekends and five employees dedicated during the work week.

Process

The process for transferring inventory will proceed in a systematic manner. In the months leading up to the actual move, warehouse inventory SKU items will be consolidated onto pallets (one SKU per pallet to minimize complexity and labor requirements). The consolidated pallets will be shrink wrapped, labeled with their destination location, and left in their location of origin until the move begins. Once the move begins, inventory will flow from origin to destination in the following manner:

- Truck backs up loading dock at origin
- Pallet removed from rack, scanned, and loaded on truck
- Truck travels to destination, pallets are unloaded
- Pallet unshrink wrapped and placed in its designated location at destination
- Once entire move is finished, a complete visual verification will ensure proper location

Lile has estimated the following time requirements for one complete truckload cycle:

- Truck loading at origin: 45 minutes
- Truck travel to destination: 20 minutes
- Truck unloading at destination: 45 minutes
- Truck return trip to origin: 20 minutes

EWEB does not have software to manage warehouse relocation. We are not aware of any standardized software program for such a specific situation. Rick Motley has devised a customized approach to handling the transfer of inventory location in the EWEB Inventory Management System (IMS). Under this customized approach, inventory items will be scanned before being loaded on the truck. The scan will trigger a false job number in the IMS that can later be updated manually to reflect the new location of the item at destination. There will not be any rescanning of the item once it arrives at destination. Inventory will be verified by a manual, visual count at the completion of the movement process.

Proposed Solution: Discussion and Critique

This section will cast a critical eye on the proposed solution in an attempt to identify opportunities for gains in tracking, reliability, and organization of the relocation process. Two primary considerations are discussed: response time lag and reliance on key staff. Within each of these two sections is a careful analysis of several specific concerns.

Trackability

Major warehouse moves naturally create a response time lag. Items are split between two locations, employees are not yet adjusted to the new warehouse space, and unexpected problems are all but guaranteed. As a utility, significantly increased response times are unacceptable. Meeting EWEB's commitment to rapid response during the nine days of scheduled moving will be a challenge. Three primary issues arise regarding response time: In-transit time: This includes the entire time materials are off of their proper shelf: picking, transporting, and off-loading. The current proposal includes moving palletized items from their

old shelf to a loading area where they will then be loaded into trucks. At the new warehouse the same process will take place in reverse. One concern with the constant flow of very different kinds of materials into the new warehouse is the varying length of put away time. Minimizing response time will require optimizing the material flows to avoid bottlenecks along the route. This optimizing will include not only which materials are shipped together but also scheduling items in a way that matches load and unload times so as to avoid goods backing up at the new warehouse.

Double picking: Moving over a nine day period will create situations where needed items are split between two locations. Additionally, the desire to move all quantity of each SKU together do not allow for duplicate inventory systems to run simultaneously. This will require additional travel time to assemble all needed parts to complete a task. A process for double picking must be considered.

Reliability

Inventory Management System: Tracking materials during a move is a much different task than what inventory management systems are usually designed to do. EWEB has created a work around to deal with the limitations of its system. The work-around involves the use of a dummy job order which records an error message in EWEB's inventory database. Despite this work-around the system does not perfectly deal with the complexities of moving to a new warehouse location. The most serious concern from the current proposal is the lack of tracking during the move. Items are scanned as they leave the old warehouse and assumed to arrive and be placed in the correct location at the new site. This system places considerable pressure on a smooth flow of materials at the new location and demands an error free put-away. Using an outgoing scan process would be acceptable if items were not critical. However, EWEB should attempt to create a more robust and accountable system that can lead staff members to the correct location immediately. IT support system: By using the existing inventory management system to handle the move EWEB becomes dependent on outside consultants and key IT staff within the organization. Leading up to the move EWEB should work to create a team of IT professionals that can complete the tasks even in the case that one of the team members is unable to participate. (Recommendation: document exact steps of sending error messages through the IMS. Ensure staff at EWEB can stand in for outside consultants or ensure a backup system can be used in case of emergency. This will avoid the entire move being dependent on one outside consultant.) Security: The chaotic atmosphere of a move combined with twice as much area to patrol suggests a security risk during the move. EWEB must patrol two

warehouses and in-transit items and do so amid relative chaos. A security incident, however unlikely, will jeopardize the entire move process.

Organization

An experienced staff is an enormous asset during a warehouse move. However, a move of EWEB's size will require considerable outside help. EWEB must consider how to utilize existing staff members to lead hired help. Currently, a total of 13-15 employees are projected to work on the move during the two weekends during which the move will take place. During the five weekdays in between, a total of eight employees will be dedicated to the move.

Systems should be created to distribute needed knowledge to all members of the move team.

Additionally, highly specialized tasks should be shared between at least two staff members so as to avoid complete reliance on one key staff member. Institutional knowledge: While the staffing levels planned are adequate based on the size and scale of the move, there is some concern about bringing in hired help that do not understand the environment

and institutional systems used at the EWEB warehouse (Benson). At the same time, EWEB employees who have worked in the old warehouse for much of their careers may resist the implementation of new systems or processes at the new warehouse. Together, these two differently motivated and trained employees must work together towards a singular goal.

Location and Procedure: Rick Motley, Warehouse Manager for EWEB, has designed the move and made careful decisions on many of the key steps EWEB will take before, during, and after the move. It is imperative that Rick document his methodology so that all members of the team understand not only their specific task but also how their task fits into the larger process.

Educating staff from EWEB and Lile around the rationale behind each step of the process will reduce the need for constant feedback from Rick in cases of slight discrepancy between plan and reality. For example, consider a case where movers unload a pallet of small parts in bins to be placed in a Stanley Vidmar™ shelving unit. If the unit has a broken drawer and staff are not prepared with a backup plan Rick will have to be present and able to give on-the-spot directions. Knowing that unexpected problems will arise during the move it is important for Rick to not end up being a bottleneck, with many individual steps waiting on Rick's attention. While it is impossible to think of every potential problem and create a back-up plan, creating a system for documenting and guiding decisions when challenges arise will reduce the dependence on one key staff member and ensure that the flow of materials continues.

Warehouse Design for Inbound Materials at Monaco RV

UG Team: Malia Harada, Alexi Wilson, Drew Kroeplin, and Scott Fogel

Industry Sponsor: Dennis Girod, Purchasing Manager

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2010

Executive Summary

The Problem

After being acquired by NaviStar in 2009, Monaco RV found itself under an order to improve efficiencies on all fronts, particularly in regards to the layout of the warehouse and the processes in which inventory is received, processed, and distributed to the rest of the plant. If Monaco wishes to be competitive going forward, they need to make changes.

Problem Solving Process

After visiting the warehouse seven times over the course of the past three months, we spent time going back and forth, using pictures, diagrams, and interviews we held with employees to outline a set of solutions that could be implemented to save both time and money. After compiling a massive list of suggestions, we slowly began to revise our work, keeping only those solutions that were realistic and could be immediately helpful. The following is a summary of those solutions.

Receiving

We recommend using the unused fourth dock, which is currently used to store defective product and returnable merchandise. By utilizing the fourth dock as a processing station for all goods that have been received, but not processed, a central transition station can reduce confusion and clutter. We also recommend instituting new rules that deter inventory distributors from grabbing unprocessed product, which results in a loss of trackable inventory.

Put-Away

We suggest purchasers group orders into production lines when inventory is received. Additionally, overstocked or unused product should be stored in the back of the warehouse. We also recommend a manual gravity feed system for replenishment of goods. Lastly, stocking a week of product in the bins will cut down on inventory costs.

Layout

In this area, we suggest separating inventory into towable and motorized sections, instead of the standard category groupings that the inventory is currently divided into. Additionally, we recommend relocating Paul and Allen's office, which occupies a spot right in the center of the loading docks, into a new place in the warehouse. These moves will improve the spacing of the warehouse, and by separating inventory into stations rather than categories, time can be saved.

Flow

We recommend removing the green racks to improve the flow of the forklifts around the back of the warehouse. Additionally, a set of guidelines for how forklifts should operate and move throughout the warehouse would help improve safety issues that we observed. Lastly, the width of the isles between the racks should be adjusted to accommodate a safe lane for forklifts to travel through.

Introduction

Monaco RV has built mobile homes for the last 42 years. Monaco has experienced much success in their industry, up until the economic downturn of 2008. In June 2009, one of the leading trucking companies, Navistar, acquired Monaco to help keep the company afloat. Since then, the company has experienced many adjustments. Upon purchasing Monaco, Navistar has requested that the coach production process become efficient. To help assist in that efficiency, Denis Girod, Purchasing Manager of Oregon Operations has been assigned to lead the way. Additionally, Monaco has asked us to suggest any changes that will help improve the receiving and put away process for the warehouse.

After visiting the warehouse multiple times over the past three months, we've analyzed a number of issues that hold up flow in the warehouse. We understand that inventory processing and distribution is an important part of Monaco's operations, and improving the efficiency of these procedures can greatly improve cycle times for employees and the production line. We believe that the following suggestions we're about to propose will tremendously decrease the amount of time it takes to receive and distribute product throughout the plant.

Receiving

New inventory shipments are currently being delivered to 3 out of the 4 docks located in the warehouse. Although the warehouse managers unload the newly delivered products very

quickly, the area and method which new inventory is stored and processed causes a number of inefficiencies in regarding flow. There is little designated room for storage between the receiving docks and the green racks, which hold larger sized inventory. Since new inventory cannot be put away before it is properly processed, the items are stored in the aisles between green racks during this in-between period. Storing most of the recently received inventory between the green racks causes congestion and difficulty when handlers try to access processed inventory on the racks. Having these unprocessed boxes spread out around the warehouse also makes it hard for the inventory receivers to control employees from taking unprocessed product.

To correct these issues, we recommend using the unused fourth dock, which currently stores damaged or returnable product, as a processing station. After merchandise arrives through the three usable docks, the new inventory should immediately be stored on the racks in the fourth dock, which can be used as a station for products yet to be filed. A designated area for these transition goods would improve the flow for the front of the warehouse and eliminate unneeded frustration between the inventory processors and the handlers. Having all unprocessed product in one centralized location will allow the inventory handler to process new product on a priority basis.

In addition, we recommend implementing new rules that prevent employees from using unprocessed inventory. There are times when product has ran out of stock and a production line station is in need of a specific product; rather than waiting for it to be processed, the material handlers will take the recently unprocessed product without the okay of the inventory processor. Although this method helps further production of coaches on the production line, it results in a loss of inventory. New polices need to be implemented for all employees within the warehouse. Besides implementing new rules that prevent material handlers from taking unprocessed inventory, the purchasers should also be in sync with one another so that they are aware a head of time of products that need to be re-ordered. By doing this it prevents the hold-up of the production line and any instance of 'losing' inventory.

Put-away

As the inventory receivers put away the processed product, we observed confusion regarding which product belonged to which production line. As package slips aren't clearly defined as to whether they are for towable or motorized lines, it has resulted in a loss of time that could be used towards physically putting away items.

To improve this problem, we suggest the inventory purchasers identify each purchase order with the production line that it is affiliated with. By making this a standard procedure, each individual item delivered can be easily classified into either towable or motorized categories.

Moreover, we recommend all unused or overstocked inventory be pulled off the production line and be stored back in the warehouse. This not only makes the work stations cleaner and more organized, but allows the warehouse managers to have a accurate idea of what is in stock and what may need to be re-ordered. This would improve operations immensely by centralizing the management of inventory in the warehouse. When inventory management was spread out throughout the stations, this often led to material handlers wasting time by having to physically check the stations to note when they needed to be replenished. With a centralized control system, stations would only need to be restocked with what is needed, and the need for individually tracking the inventory levels at all the different stations would be eliminated, saving time and headaches in the process.

We also recommend implementing a manual gravity feed to improve the replenishment process for all stations on the production line. This concept improves the efficiency of a kanban system. Although it might seem like a hassle to set up, it would greatly streamline the process of getting inventory off of the shelves. When one package—for example a small bag of bolts—is pulled off the shelf, another takes its place. By feeding all the incoming inventory into pull systems like this, the gathering of inventory to take to the stations, an extremely frequent activity, becomes much easier and faster. This would in turn save employees time, allowing them to focus on other tasks and become more productive.

Lastly, we suggest stocking two weeks' worth of product in the bins, letting it eventually go down to 2-3 days of inventory. The buildup of inventory we observed was unnecessarily large, and by sticking to fixed amount of inventory (measurable in days), the job of the purchasers can be greatly improved. Stocking large amounts of product in the warehouse only adds to the clutter and confusion, and the space saved could be of great use to the employees in the warehouse. With a cleaner layout and less inventory, inventory becomes easier to manage and material handlers don't have to spend time picking through lots of bins to find what they need. By implementing a cap on the amount of product in bins, operations in the warehouse can run much smoother.

Layout

Currently, the layout of the warehouse is grouped by categories, such as wiring, electrical, and refrigeration. Although there are two separate production lines, the supplies are stored with one another, making retrieval tedious and inefficient. Merchandise handlers have to go through multiple stations to gather all the materials they need before they distribute product to a production line. This is an inefficient use of time as it forces the handlers to travel to multiple locations in the warehouse just to restock a specific station.

We recommend organizing the warehouse so that inventory is stored by motorized on the north side and towables on the south side. Within this framework, we also suggest implementing fixed locations that are designated to each station. This applies to both the green and blue racks. For items that are universal, we recommend storing these in a central location between the motorized and towable areas. Additionally, fixed locations within each side can be placed so that they are closest to their corresponding spot on the production line. More frequently used items can be stored closer to where they're going to be used. This ensures that production lines can be filled and stocked in the least amount of time possible.

To facilitate a better flow within the inventory receiving area, the small office that Paul and Allen currently occupy should be taken down or relocated. The location of this office wastes space that could be converted into much needed room to manage the incoming inventory. Reducing the cluster and logjams that stem from the current layout will improve time efficiency for all employees involved.

Flow

Along with the organization between the two lines of production, we noticed that there is no through-way for employees and forklifts to easily move from the warehouse to the production lines. At the moment the green racks placed at the end of the warehouse aisles have closed off each passageway which prevents the flow of traffic and also increases the congestion within the warehouse. We recommend that some of the green-racks closing off the back area should be removed as to open up the floor layout and allow for multiple material handlers or forklift operators to be able to access the same inventory without having to travel around the perimeter of the warehouse before delivering the inventory to workstations. We observed that the traffic within the warehouse was chaotic and that the forklifts and employees had limited options when traveling to and from destinations. This lack of structure and order caused a lot of 'traffic jams',

where forklifts were forced to wait for areas of the floor to clear before they could continue moving. This stop and start nature is not only timely inefficient, but also dangerous.

To correct these issues, we recommend implementing a set of guidelines for how forklifts and employees should travel around the warehouse. These guidelines should include either a clockwise or counter-clockwise flow for the forklifts and designated pathways for walking employees to prevent any unnecessary collisions or accidents. In addition, the warehouse should implement separate direction of flows for the two separate production lines. On the towable production line, forklifts needing inventory from the green racks should enter from the eastern side of the rack and exit out of the western side of the green rack to the left. Likewise for a forklift needing inventory from the blue racks forklifts should enter from the western side of the rack, and exit out of the eastern side to the right. On the motorized production line the forklifts heading for the green racks should enter from the eastern side and exit from the western side to the right. Similarly, the forklifts heading for the blue racks should from enter from western side and exit from the eastern side to the left.

In addition to all other flow implementations, the width's of the isles between the green racks need to be checked and adjusted if necessary for the proper widths to fit the turning radius of both types of forklifts. This adjustment must be made so that both the stand up forklift as well as the sit down forklift can enter the aisles, pick up their inventory and be able to make a full 360 degree turn. It is not important however for the blue racks to have such a wide widths to accommodate the forklifts. The blue racks need only to be accessible to hand carts and their standard width and turning radius.

Conclusion

By adhering to these proposed changes, we can largely eliminate many of the inefficiencies that currently plague the Monaco warehouse. All of our suggestions were conceived with the intention of not only speeding up productivity, but also improving the flow and layout of the warehouse itself—something that we feel can be extremely beneficial in regards to work space design and organization. Dennis has been very accommodating to our requests throughout the course of this project, and for that we are thankful. By thinking about efficiencies from both a design and process perspective, we've learned valuable lessons that we will be able to apply not only for this project, but after college as well.

Organically Grown Company Product Coding Project

MBA Team: Doug Anderson, Katie Brennan, Paul Clark, Kelly McKeag, and Dan Simon

Industry sponsor: Josh Hinerfeld, CEO; Jason Smith; Waylon Spoden; Robbie Vasilinda

Faculty Adviser: Nagesh N. Murthy

DSC 577, Spring 2010

Executive Summary

Organically Grown Company (OGC) is dedicated to promoting health through the distribution of organically grown fruits and vegetables. This dedication has created a company culture and level of service that is reflected in its inventory management system (IMS) of over 25,000 product codes. Each code has five sections that point to various feature of a product such as type of produce, count, brand, grade, and organic certification. This multi-tiered level of coding allows for a high level of flexibility and sales response; however, it is also prone to errors and requires additional inventory-monitoring steps that are costly and inefficient. The purpose of this project was to:

- ☐ Evaluate the tradeoffs associated with adjusting or reducing the code sections
- ☐ Identify which pieces of the product code are most important
- ☐ Assess the financial impacts associated with maintaining the code system
- ☐ Recommend opportunities for improvement

The challenge was providing recommendations that respect the current organizational structure and mission of the company, maintain an expected level of service to both small and large customers, and propose financially responsible adjustments minimal disruption to the current operations. The cornerstone of the assessment process was to collect data via a survey sent to employees, vendors, and customers to shed light on the overall perception and functionality of the code. Based on the analysis, both short- and long-term actions are recommended:

Short-term :

- ☐ Continue to explore alternatives with customers
- ☐ Look for solutions that will result in increased employee productivity
- ☐ Gather more survey data to inform pending adjustments needed for the code

Long-term:

- Remove the Brand or STM section of the code
- Replace specific counts to quantity ranges
- Implement incrementally to gauge success

The growing demand for organic and higher quality produce is creating a distribution environment that requires faster response time and product integrity. Although OGC has core business competencies to meet this growing demand, an adjustment to its inventory management system with a long range view to implement a more automated counting and controlling system will only expand opportunities. This report represents just one change that will facilitate future business and environmental performance.

Background

The mission of Organically Grown Company (OGC) is to “promote health through organic agriculture as a leading sustainable organization.” It accomplishes this objective through offering over 300 produce items to grocery stores, natural food stores, restaurants, buying clubs, and food service establishments throughout Oregon.

OGC relies on a detailed and involved inventory management system (IMS) to keep track of all incoming shipments, customer orders, and outbound deliveries. OGC currently employs a software solution called Produce Pro to manage its inventory-related activities. The company of the same name customizes for its clients the IMS software, which has become a key piece of OGC operations and interactions with partners on either side of the supply chain.

Problem Scope

OGC has made a commitment to its customers to be as transparent as possible in its operations. This transparency is exemplified in OGC’s ability to show a customer exactly where a particular piece of produce was grown. To do achieve this level of service, the company must maintain a complex inventory system that allows traceability of each individual item of hundreds made available from more than 400 growers (see Exhibit 1 in this document’s appendix). Each produce item is assigned a particular product code based on its type, variety, label, grade, and organic status, resulting in roughly 25,000 stock-keeping units (SKUs) in the IMS (see Exhibit 2 above). As one can imagine, the system is extremely complex and prone to user-based errors.

Exhibit 2 – OGC Product Code Components

At the center of this increasingly challenging system is an internal debate surrounding the importance of having such a detailed product coding system. The two polarized positions are summarized as follows:

1. Some staff members, including the marketing department, believe the detailed coding system offers a source of competitive differentiation from other warehouse distributors.
2. Other staff members, especially those involved in managing the logistical aspects of the IMS, believe the coding system limits the operational efficiency of the system—especially in data administration and operations. A more balanced approach suggests striving for a middle ground where OGC can optimize its product code system, so that it can provide brand-level specificity to its customers while eliminating the perceived inefficiencies attributed to the current produce code structure.

Key Objectives and Challenges

Objectives

The MBA consulting team worked to meet the following key objectives:

- Evaluate the tradeoffs associated with adjusting or reducing the code sections
- Identify which pieces of the product code are most important
- Assess the financial impacts associated with maintaining the code system
- Recommend opportunities for improvement

Challenges

There exist four key challenges that exist with updating the product coding system. The first challenge pertains to the current organizational structure that OGC has developed over the years. OGC prides itself on having a relatively flat and networked company culture.

Management is easily accessible, and ideas flow freely throughout the company. The employees feel as if they each individually own a piece of the company, which engenders employee loyalty and retention. Where this poses a problem is when the employees get too used to the familiar operations of the company or perhaps become so involved that it becomes difficult to evaluate different options and potential changes without bias. OGC must find a way to improve efficiency through improvements in the product code while still fostering the unique company culture.

OGC also wishes to uphold its commitment to smaller-volume customers by offering as much visibility into the product line as possible, particularly when dealing with customers that are

highly brand-oriented, or perhaps more reliant on specific product counts. Any update to the coding system might directly impact the way OGC does business with these smaller-volume customers, so it is important to propose changes that will consider all positive and negative effects on these customers.

Next, it is important to design a code change that causes as little disruption to the internal and external processes of the company as possible. Any type of code change will require a degree of training within the company as well as additional efforts needed to educate customers on any new processes. The changes must be designed so that the implementation will minimize the total external and internal disruptions, further allowing the successful transition from the old system to the new.

Finally, OGC must thoroughly evaluate the cost and service tradeoffs that will come with making changes to the product coding system. One of the easiest ways to reduce the complexity of the code is to eliminate unnecessary components, which seems to contradict the idea that the current code has been created through a series of necessary improvements. Notwithstanding initial intentions, it is now critical to eliminate the parts of the code that are least necessary and evaluate the impacts that these eliminations will have on specific cost drivers within the company.

Methodology

To satisfy the project objectives, the group used four specific methods to gather and interpret information as to how the current product codes are used by every piece of the supply chain to gain information from all internal and external stakeholders of the company. The following methods for acquiring information from stakeholders—including OGC employees, suppliers, and customers—were used during the course of this project:

- ☐ Warehouse site visits
- ☐ Employee informational interviews
- ☐ Stakeholder surveys
- ☐ Historical operational data analyses

Warehouse Site Visits

The warehouse site visits were used to gain first-hand knowledge of the specific operations of the company, to see how the various staff members used the code, and to better understand how employees could be impacted by product-code changes. The site visit also provided the

opportunity to witness the supply chain in action as an incoming shipment was followed from its arrival at the warehouse to its departure en route to a customer.

Employee Informational Interviews

Various employees within the company were interviewed to gain further insight as to how the codes were used and gain insight into how changes could potentially impact the company's operations. Employees throughout the value chain were interviewed based on their interactions with the codes, including employees in sales, purchasing, inventory, systems management, and warehousing capacities. Each employee group used the codes in different ways and gave key insights as to which parts of the code were most crucial to the successful completion of their respective job duties.

Stakeholder Surveys

Much like the informational interviews, stakeholder surveys were developed and distributed to see how important specific aspects of the code are to those internal and external audiences. The primary stakeholders identified were customers, employees, and suppliers. Each survey was tailored to the stakeholder group, and each can be found in the appendix in exhibits (see Exhibit 3 in the appendix).

The customer surveys were tailored to gain a sense of how important the specific visibility factors were as they related to the customer's satisfaction in doing business with OGC. Because the customers have no direct interaction with the product code, the survey gauged the importance of the indirect effects of the specific pieces of the product code. Specifically, the questionnaire sought to quantify the importance of the visibility factors when purchasing produce from OGC, including variety, count, size, label, brand, price point, organic status, locality, and grade. These factors were then ranked against other value-added offerings that include order accuracy, recovery, credit processing, response time, and product availability. The internal survey was tailored to investigate the specific use of the product codes of each employee in an effort to quantify the importance of each visibility factor as it related to effectively performing one's job. The surveys also asked employees to rank the level of difficulty each attribute played in executing respective job duties.

Finally, the supplier survey was used to gauge each grower's perceptions of doing business with OGC. Particularly, the survey looked to quantify how difficult it is for individual growers to

meet the OGC code requirements. The survey also aimed to benchmark the interactions with OGC operations against the growers' interactions with other warehouses and distributors.

Supply Chain Management Project at StoveTec

MBA Team: Brett Ratchford, Tracy Reyes, Linda Anson, and Mohammad Rashid Rasool

Industry Sponsor: Ben West, General Manager; Miles Makdisi, Office Manager

Faculty Adviser: Nagesh N. Murthy

DSC 577, Spring 2010

Executive Summary

StoveTec is a growing company with a mission of improving human and environmental health in developing countries through the design and distribution of an improved cook stove. To help subsidize the cost of the stove to people in third world countries, it markets its stoves in the US as well, at prices as much as five times the price charged in third world countries. Profits from sales in the US market contribute to StoveTec's wider distribution in countries where environmental and human health are more at risk. In these countries an estimated 1.5 million people – especially children and women – die every year from breathing in the emissions from open fires. StoveTec asked our team to make recommendations for its supply chain to help maximize US profits.

The historical US sales data provided by StoveTec shed light on the company's purchase patterns, freight costs, distribution of customers, and inventory costs. Communications with Ben West, StoveTec's General Manager, provided background on the factory in China, the land and sea carriers currently used, the location of its US distribution center, and the services provided by a third-party logistics company. Our team evaluated the data and information to determine the:

- Economic order quantity and reorder points to ensure appropriate inventory;
- Least costly means of moving product from the US port to the distribution center;
- Best way to bring shipping charges in line with customer expectations; and
- Most appropriate management software to help StoveTec optimize its operations.

We formulated our recommendations to meet the criteria of serving US demand within a reasonable length of time, with minimal inventory and shipping costs, and with the assistance of software capable of optimizing current and future profits from StoveTec's growing US market.

Background/Context

StoveTec is the for-profit affiliate of Aprovecho Research Center, a non-profit organization that is a world leader in open-source development of improved cooking stoves. With its manufacturing partner in China, StoveTec produces and sells low-emission cooking stoves to some of the three billion people around the world who use open fires to cook their meals. StoveTec also sells its stoves in the United States, and asked our team to recommend supply chain improvements pertaining to its US distribution.

Problem Scope

During the company's short history, StoveTec has set up relationships with a manufacturer, a shipper in China, and a US based logistics and warehousing company to help the company fulfill the orders it receives. StoveTec has achieved enough scale in its US sales to benefit from comparing alternative ways of filling orders with the goal of improving its profit margins. In addition, with the recent hire of a sales professional, a consolidated effort to market the stoves in new regions, and recent positive press coverage for the stoves, StoveTec hopes to double its US sales in the next year. Now is the right time for StoveTec to consider a number of supply chain and logistics issues in order to ensure that future sales do not put too much stress on the current business model.

In order to optimize StoveTec's supply chain, our team identified several challenges. First, we wanted to reduce costs associated with holding excess inventory and avoid missed sales due to too little inventory. Next, because StoveTec had received customer feedback that sometimes the customer's shipping cost for a stove was close to half the price of the product, we wanted to explore flat-rate pricing for shipping. We then planned to analyze if it made more sense to roll the shipping cost into the product price or for it to remain an additional cost. Third, we wanted to explore ways to minimize the aggregate costs of moving products from the factory in China to the US distribution center. Finally, to help StoveTec optimize its business currently, and prepare for substantial growth over the coming year, we wanted to find a software product affordable to StoveTec that would systemize the data and functions currently maintained in the head of one employee. See *"Getting Inventory to the Distribution Center"* and *"Getting Product to the Customer"* at end of report.

Key Objectives of Project

Specifically, our team was tasked with:

1. Putting together a tool for determining StoveTec's economic order quantities and reorder points;
2. Analyzing historic, zone-based shipping costs for this very heavy product, determining a mean flat rate, and recommending a better alignment of shipping costs with product price to meet consumer expectations;
3. Determining the best location for its US distribution center; and
4. Researching which Enterprise Resource Planning (ERP) software could, at a reasonable cost, help StoveTec manage its inventory, tracking and forecasting processes.

Solution Methodology

Early in the term, our team toured StoveTec's facility in Cottage Grove, and met with General Manager Ben West to learn more about the company and its operations. The supply chain is fairly straightforward. Product is shipped from the factory in China to the Port of Portland, trucked to the Eugene distribution center, and then unloaded by Lile Logistics Services into the distribution center. Customers place orders online through StoveTec's website. Lile packages the orders and schedules FedEx Ground to pick them up and deliver them to customers. Although StoveTec has never requested it, the factory in China has capacity to hold inventory at no cost; however, payment for its production is required prior to manufacturing.

We requested historic data for customer orders (stove style and quantity), customer shipping charges, customer zip codes, and the prices charged by Lile. StoveTec has served the US market for less than one year, so we received partial-year data.

By digging into the data supplied by StoveTec, we began to learn more about the characteristics of the company's demand trends and inventory levels. Demand is expected to be the same as it has been with no seasonality, trend, or change in distribution pattern. StoveTec does not know how many orders have not been filled due to lack of inventory. It is unaware of this because, in the event of a stockout, a notice is simply posted on the customer website saying it is awaiting its next shipment of stoves. The 5- to 10-day order fulfillment time appears to be acceptable for customers. Most of StoveTec's customers care more about efficiency and cost of the product than the perceived responsiveness in the supply chain. While the majority of US orders have been for single stoves, some very large orders came in randomly. These random

but large orders are expected to continue. We also learned the current inventory level in the Distribution Center (DC), as well as lead times for each step in the supply chain process.

Inventory Management System Analysis II at Myers Container

UG Team: Greg Zimet, Luke Leon, Katelyn Sanders, and Eric Eszlinger

Industry Sponsor: Taylor Gordon, System Analyst

Faculty Adviser: Nagesh N. Murthy

DSC 477, Spring 2010

Executive Summary

The Company

Myers Container is a company that focuses on manufacturing industrial packaging, primarily new and reconditioned steel drums. Beyond drums and containers, they offer a variety of services. Currently, the company uses a hybrid method of inventory control.

The Problem

Myers Container has an intuitive and sporadic inventory control system that leads to increased costs. Below are the main drivers of the cost increase:

- Holding costs
- Inventory costs
- Shipping costs

Myers Container realizes costs that are higher than necessary given a desired service level. To align the operations at Myers Containers with strategic goals, a just-in-time, kanban system would be ideal.

Project Objectives

- Focus on a subset of inventory (55 gallon drums) for an ideal solution that can later be applied to all inventory items to increase efficiency
- Determine the cost that Myers currently experiences and provide a solution to decrease those costs based on historic data while maintaining a given service level.
- Increase the efficiency of the system overall
- Provide jump off point (excel tool spreadsheet) to move closer to JIT, kanban system.

Solution Methodology

Historical data allows calculations for safety stock, reorder point, and economic order quantities for each inventory item. An excel spreadsheet was created as a tool to manipulate identified variables to consider different scenarios. Right now, the tool considers the current costs.

The new method saves Myers Container \$23,086 (all other things held constant).

Recommendations

Adopt the proposed method. Use it as a starting point and gradually adjust to all inventory items for greater cost reductions. Consider implementation barriers such as supplier coordination, supplier cooperation, and organizational change.

1. Company Background

Myers Container, LLC is a manufacturing company that focuses mainly on steel drums. Myers is part of a joint venture with Container Management Services, LLC. that offers services that focus on environmental programs like drum recycling and reconditioning. In addition to manufacturing steel drums, the company offers supplementary services such as Vendor Management, Backhaul Freight and Drum Loads. Myers currently has two new steel drum manufacturing plants; one in Oregon (Killingsworth) and one in southern California .Our project focused on the new drum manufacturing plant at the Killingsworth location in Portland, Oregon.

In order for Myers to maintain its service level for its customers and keep its plant functioning optimally, a system needs to be in place to facilitate the needs of demand and a way to maintain required inventory levels. The inventory must be managed on a continual basis throughout the production process. This process consists of receiving components from a supplier, assembling those components, and then selling the finished products to customers. For the purpose of this project, our group focused on the data from three categories of parts: heads, bottoms, and covers.

2. Project Scope

For Myers Container, managing inventory is important to ensure they are paying the lowest possible combination of shipping and holding costs. Our project's focus is going to be on making sure that costs are lower than the current inventory system that Myer's currently has. In the past, Myers was bound to not having very good access to the data that was important to making inventory and ordering decisions. Only until recently has all the data been all collected and put

into the computer to make it easier for all aspects of the company to analyze and use the data. The problem lay in the fact that the company has the access to the combine computerized data, but now it wants to use that data to help with inventory levels and inventory ordering. The current system for ordering parts is more out of intuition. For example, an employee who was knowledgeable about the components and past demand would make educated guesses for decisions regarding inventory order details. Orders are usually placed once it is noticed that quantity is getting low or once a stock out is close and it is noted that the parts will be needed to fulfill an upcoming order. This creates a problem in that either too many parts are ordered and Myers has a buildup of inventory that will increase inventory and holding costs, or enough won't be ordered leading to delays in production and order fulfillment. All of these problems are creating extra costs for Myers as well as limiting space in the factory because of all the storage of the extra inventory. Our hope is to find equilibrium between order points and quantity to ensure the number of units that Myers has on-hand will satisfy demand and lower holding and shipping costs.

3. Key Objectives

Overall, we wanted to create a tool that would help Myers keep track of inventory order points, and quantities as well as the costs that will be involved with holding and shipping inventory. The scope of our project was to take the data that Myers had to give and run analysis and calculations to find important inventory data that would help Myers. Our objective is the building blocks to transform Myers current hybrid inventory system to more of a Just-In-Time/Kanban system.

From the data we calculated demand based on purchase history, economic order quantity, minimum levels of inventory, and maximum levels of inventory and the cost implications of shipping and holding inventory for each part. We had to take into account some restraints that Myers faces with regards to minimum order quantities and limits on the freight trucks from Myers suppliers.

4. Solution Methodology & Assumptions

With regards to the data that we received from Myers, we calculated yearly demand based on the order history that Myers made from their suppliers. We also assumed that their demand was linear with no seasonality. We also made the assumption that Myers reorders a component once it is close to stock out. A few things that were important to our calculations were Myer's minimum order quantity from suppliers is 100 units for each component and the averaging of

truck deliveries so that Myers is receiving truck deliveries twice a week. Also assuming that the truck loads are not full loads.

The steps that were taken come up with this solution took several twists and turns (See attached Excel output file). After receiving the 16 month ordering history from Taylor, the first thing that was attempted was to create a schedule of what to order when, based on the number of trucks Myers Container receives per week. After thinking this out it was decided that this was not the right path to take because Myers wants be reactive to levels of inventory, not set on a strict schedule. This also wasn't ideal because the goal of this process was to create savings in shipping and holding costs and this method doesn't cut shipping costs at all.

Then there was an attempt to create optimal order quantities and reorder points and determine how many of each part to order per week and how often to order the parts that don't need to be ordered every week because of the lower demand and minimum order quantities. This method also isn't ideal because it didn't lower shipping costs and it made too many assumptions about demand being perfectly even across time and created too rigid of an ordering schedule. Our final method, of which a spreadsheet is provided, is the most ideal process for Myers to reduce shipping and holding costs.

The first calculations that were done were the yearly and monthly demand, the standard deviation, the reorder point, the safety stock and demand during lead time of each product that there was demand history for. Then the total weight of all the products that Myers demands in a year was calculated and then divided the capacity of a truck. This calculation shows that the minimum number of trucks that Myers requires per year to meet demand is 67 trucks. An input box was created to allow the user of the spreadsheet to alter the number of trucks that were to be received per year. When this number is changed, the quantity per order of each part changes, as well as the days between orders/trucks, the shipping cost and the weight per truck.

The quantity of each item to be ordered depends on the number of trucks and the demand of that part. If the number is less than 100, then obviously that amount cannot be ordered. It must be decided how often to order those parts which do not have order sizes over 100 (every other week, every third week, etc.) based on current inventory levels. There is also input boxes for lead time and the cost of shipping a truck, which could change depending on negotiations with the supplier and trucking company (if you were to order full trucks they might charge less and make straight trips to Myers for example). There is also an input box for desired service level which, when changed, alters the safety stock and reorder point of each product, which

determines holding cost. The higher the service level, the higher levels of inventory that must be kept on hand. Lastly an input box was created for holding cost of inventory, which could be changed depending on the opportunity cost of buying and storing inventory.

For the current cost of shipping and holding, it was assumed that the cost of a single shipping truck was \$1,292 and that 100 trucks have been come per year to Myers. It was also assumed that the average value of inventory of prior months was the average value of products ordered. The average value of inventory multiplied by holding cost percentage and added to the shipping cost gives us the cost of holding and shipping per year under the current method used at Myers. The cost of shipping and holding under the proposed plan is also given using the same assumptions but using the inputted costs of shipping and service level. The difference between the two methods shows the user the yearly savings.

5. Recommendations

With the information gathered above, our proposed solution should be used as the first steps to a fully integrated solution across all inventory items. Myers Container has the possibility to save **\$45,786** if our solution is followed, conservatively. Given the scope and objectives given and our solution methodology we would recommend the following:

- Adopt 70 trucks a year for shipping
- Carry and order at specified levels of safety stock, reorder points , and EOQ
- Allow multiple adaptive shipping configurations.

We recommend for Myers Container to use 70 trucks spread out over the year as a way to ship their incoming heads, bottoms, and covers from the supplier. This move from 100 to 70 trucks will reduce the total shipping cost without hurting Myers ability to fulfill orders. This reduces their two trucks that come weekly to just one truck that arrives every 5-6 days.

It is also important that Myers Container carry and order at our specified levels of safety stock, reorder points, and Economic Order Quantity. However, it is important that Myers is flexible in these quantities due to the restrictions on minimum order quantities. We recommend that Myers orders the items it demands most throughout the year on every truck at our designated EOQ. With the smaller items, it is important that Myers strategically spread these out onto shipments that have less weight carried on them. For example, an item with an EOQ of 56 should place on every other truck and an item with an EOQ of 10 should be placed on every tenth truck.

Given this method, it possible for Myer's to create a yearly schedule of delivery. However, it is important that Myers maintains flexibility in their ordering. They must make sure that they are able to add emergency orders to their inventory without adding additional trucks and allow multiple adaptive shipping configurations. It is important to notice that our solutions include intuitive methods of ordering even though we have laid out economic order quantities. Myers must maintain the ability to order more of an item in case of an emergency stock out or added demand.

Appendix B – Worksystems Inc. Final Report

Executive Summary

NW Manufacturing Initiative Contracts:

Worksystems, Inc. (WSI) is a nonprofit organization serving the City of Portland, Multnomah and Washington counties. The mission of the organization is to build a comprehensive workforce development system that supports individual prosperity and business competitiveness.

The organizational values essential to the growth and vitality of the system include:

- A skilled workforce that improves business and individual competitiveness, earning capacity, income and assets.
- Partnerships that support alignment, effectiveness and continuous improvement.
- High standards of accountability to the community.

In pursuit of its mission, Worksystems:

- Provides a single point of focus for regional workforce efforts.
- Builds linkages between regional government, business, labor, education and other leaders to enhance regional workforce programs and services.
- Invests in education, community-based and industry partners to provide skill development and related services.
- Supports projects to foster innovation, expand best practices and encourage system change.
- Coordinates workforce development activities with regional business, economic development and education strategies.
- Evaluates system quality and outcomes.

To ensure a responsive, demand driven workforce development system, WSI regularly engages targeted industry businesses to inform regional workforce services and investments. WSI has extensive experience in managing highly regulated Federal and state resources. Through this experience WSI has policies, processes and procedures in place to ensure that funds are spent on allowable and appropriate trainings. There are also advanced data systems and management protocols in place for monthly and quarterly monitoring of contract expenditures and program goals.

Serving as the fiscal and administrative agent for the workforce component of the NW Manufacturing Initiative, WSI awarded DLA funding to 19 Pacific NW defense contractors to support training for their existing workforce. All training was focused on continuous improvement across a variety of areas including: Leadership and Supervisory Training, Lean Manufacturing, Six Sigma Black Belt, train the trainer and technical support in implementing continuous improvement projects. All of the trainings were focused on streamlining processes, and increasing efficiency and effectiveness in either producing a more cost effective product or developing new products that support the defense industry. Several of these companies have

expressed a need for additional training funds and new companies have requested training funds as well.

Appendices

Serving as the fiscal and administrative agent for the DLA funds that supported incumbent worker training for Pacific NW defense contractors, WSI awarded funds to defense contractors through a competitive solicitation process. The criteria for the DLA contracts was created based on similar projects that WSI has managed in the past, and in consultation with Manufacturing 21. For the solicitation a Request for Proposals was advertised following standard protocols and proposals were received from a variety of defense contractors and training institutions representing consortia of defense contractors. An evaluation committee, made up of staff from the SW Washington Workforce Development Council (SWWDC), the Portland Development Commission and WSI, reviewed and scored proposals based on specific criteria. Grants were awarded to proposals that were cost effective and most likely to increase the ability of the Defense Logistics supply chain to manufacture quality products for the US Military.

WSI maximized the cost effectiveness of the funds for companies in the defense industry supply chain by encouraging consortia applications. WSI convened existing industry associations (Manufacturing 21 and Pacific NW Defense Coalition), defense contractors and training vendors to notify them of fund availability and provide opportunities to network and develop consortia applications. Training vendors interested in applying for funds to train businesses were required to submit references and letters of support from companies that planned to participate in their training.

After grant awards were made, WSI contracted with training vendors, individual defense contractors and company consortia to provide process improvement training to incumbent workers at defense industry contractors. WSI established reporting guidelines and protocols to monitor that funds were used in an appropriate manner and met the intent of the NWMI. WSI worked with contractors to develop training plans and then monitored for satisfactory completion of training deliverables that were outlined in submitted proposals.

The following project summaries describe the training that was completed with each grant award. The summaries include:

- Participating defense contractors and training organization
- Training activities
- Amount of the grant award
- Number of workers trained
- Training completed and goals
- Results of training.

The Six Sigma Process Improvement Consortium

The Six Sigma Process Improvement Consortium was awarded \$76,600 to provide Lean/Six Sigma Champion training, Black Belt certification, Train-the-Trainer, and Onsite Black Belt project training and support to 60 workers of six defense contractor companies. This consortium formed by Clark College consisted of the following companies located in Oregon and in Southwest Washington who are engaged in the defense logistics supply chain providing products to the United States military as part of their business model:

- 1) **Siltronic Corporation – Portland, Oregon:** Manufactures ultra-pure silicon wafers with diameters of up to 300 mm. These wafers are used by numerous chip manufacturers including IBM, Intel and AMD and are incorporated as components into products that are sold directly to the US Military.
- 2) **FLIR Systems, Inc. – Wilsonville, Oregon:** Manufactures Airborne, Maritime and Land-based Thermal Imaging Systems that are sold directly to the US Military.
- 3) **Leatherman Tool Group, Inc. – Portland, Oregon:** Manufactures and sells products directly to AAFES (Army and Air Force Exchange Service), NEXCOM (Navy Exchange), Marine Corps Exchange, GSA and indirectly through prime vendors such as ADS and Source One. The most popular products purchased by the US Military are Wave, Charge, Core, Surge, and Blast.
- 4) **Merix Corporation – Forest Grove, Oregon:** Manufactures technologically advanced printed circuit boards from quick turn prototypes through volume production. They work directly with US military customers that employ embedded resistors, advanced thin-film embedded capacitance and HDI structures. They are also MIL-PRF-31032 certified.
- 5) **Pulse Engineering, Inc., Vancouver, Washington:** Designs and manufactures a broad range of interface transformers and custom electronic components that are sold directly to the US Military including FibreChannel, SONET/SDH/E4/STM-1, Firewire (IEEE 1394), MIL STD 1553, transformers and delay lines.
- 6) **Tidland Corporation, Washougal, Washington:** Designs and manufactures air shafts, slitting knives and equipment purchased by companies such as Cytec Engineering, Western Advanced, Hexcel Composites and Boeing that are then used to produce products that are purchased by the US Military.

Clark College partnered with the ETI Group and companies listed above to form the Six Sigma Process Improvement Consortium. The goal of the Consortium was to provide an opportunity for manufacturing companies engaged in the U.S. Defense Logistics Supply Chain to work together to enhance and/or streamline their manufacturing operations in a way that would ultimately benefit the US Military. The companies participating in this proposed training consortium maximized the investment by taking advantage of a clustered classroom training where ideas, challenges and solutions from the other participating companies were analyzed, discussed and shared.

Each participating company not only learned how to apply the Six Sigma process improvement methodology within their organization, but also completed a company sponsored process improvement project to enhance or streamline the Pacific Northwest Defense Logistics Supply Chain. The actual results and impact of the training on the manufacturing operations of each participating company were captured and reported back to WSI in a report following the completion of the project.

The program began in February 2010 and was delivered as a combination of clustered classroom and company specific, onsite on-the-job-training. Classroom training was comprised of a 16-hour Process Improvement Leaders/Champion program and the core 136-hour Black Belt and Train-the-Trainer programs. An additional 8 hours of on-the-job training for each consortium member supported the specific process improvement projects identified at each participating company and also expanded the training to other employees.

Six Sigma Champion, Six Sigma Black Belt, Train-the-Trainer and on-the job training (160 hours)

This training program took five months to complete:

- 1) Each company participating in consortium program sent two managers to participate in two-day duration (16 hour) Six Sigma Leaders / Champion training program.

Six Sigma Leaders (Champions) are management leaders responsible for identifying, prioritizing, chartering and managing Six Sigma improvement projects. They are also responsible for removing organizational barriers to ensure success of improvement projects. Participants in this program learned the basic principles of Six Sigma; how to select, prioritize and manage Six Sigma improvement projects; and the roles and responsibilities of a Six Sigma Leader/Champion.

- 2) Each company participating also sent three key employees to participate in a 16-day duration (128 hour) Certified Six Sigma Black Belt training program.

This highly interactive program followed the classic Six Sigma **Design, Measure, Analyze, Improve and Control (DMAIC)** process improvement cycle and covered the American Society for Quality (ASQ) recommended Six Sigma *Black Belt* Body of Knowledge. Deep theoretical

knowledge was combined with substantial practical experience, state-of-the-art software, in-class exercises and activity-based workshops.

Classroom training sessions are interspersed with periods of work on actual company-supported process improvement projects. Training classes were held in a series of eight, two-day sessions scheduled from February 2010 thru June 2010.

Participants in the Black Belt training program were also provided with all the necessary texts, workbooks, data sets, and temporary licenses to use JMP and iGrafx software programs.

Each participating company sent an additional three to five key employees to participate in a one-day duration (8-hour) Train-the-Trainer program to assist them in becoming their company's in-house Six Sigma Process Improvement trainer. This Train-the-Trainer program, combined with skills and knowledge gained during the Black Belt program, helped to ensure post-grant sustainability of this initiative by providing each company with an in-house trainer capable of teaching other employees the Six Sigma Yellow Belt and Green Belt Process Improvement methodology.

Each participating company in the Six Sigma Process Improvement Consortium Program also received one day (8-hours) of on-site training and support. This provided nearly 60 additional employees with basic improvement training and enhanced the project's sustainability by expanding the Six Sigma training to other employees. It also ensured that the company-sponsored Six Sigma Process Improvement projects were completed in a timely manner.

Training Outcomes and Benefits

- I. Each participating company learned how to apply the Six Sigma Process Improvement methodology to make measurable improvements in processes that impact product quality, performance and delivery in the defense logistics supply chain and for the ultimate end user, the United States military.
- II. Additionally, the outcome of the Six Sigma Process Improvement training was that a Black Belt applied what he or she learned by leading or participating in an ongoing series of improvement projects prioritized by his or her organization. Depending on the focus of the improvement project, one or more of the outcomes listed below may be realized. The outcomes achieved over time are determined by the benefit metrics adopted by the organization for selecting and prioritizing improvement projects. Improvements included some or all of the following:
 - a. *Enhanced customer satisfaction through improvements in on-time delivery and reductions in customer returns and/or complaints.*

Customer satisfaction is a primary focus of Six Sigma and these are very common benefit metrics. Six Sigma starts with understanding the "Voice of the Customer" and participants in this training program learned how to: 1) determine spoken and unspoken (latent) customer needs; 2) identify and prioritize projects to improve their company's ability to meet these needs, and 3) develop metrics to track progress in meeting these needs. Typical

metrics include on-time delivery, reduction of customer returns and/or customer complaints.

b. Improvements in productivity and efficiency

A process operating at Six Sigma levels experiences only 3.4 defects per 1,000,000 opportunities significantly improving productivity and efficiency. Typical metrics include cycle time, inventory turns, value added versus non-value added, utilization of floor space, machine capacity & capability. Although it should be noted that these metrics are less common drivers of Six Sigma improvement projects, they often occur as by-products of improvement projects directed at customer satisfaction.

c. Reductions in cost

A very common benefit metric for Six Sigma outcomes of every project is measured by improvements in customer satisfaction and reductions in cost. Training program participants learned how to apply Six Sigma tools and methods to dramatically reduce waste, rework, complexity, defects and delays in their organization's business processes.

This unique training program leveraged a clustered classroom training model which significantly reduced the cost of delivering a 160-hour comprehensive curriculum to 6 organizations. The clustered classroom training was balanced with individualized onsite support which allowed the program to have a maximum impact and relevance to each of the 6 companies specific process improvement needs. As a result, the companies participating in the consortium training project maximized the benefit of their employee's time attending the program.

The sum total of all trainees' full payroll while in training was approximately \$80,000. This contribution by the 6 participating companies represents, at minimum, a dollar for dollar in-kind match of salary to the training investment.

The Manufacturing Training Consortium

The Manufacturing Training Consortium in partnership with Clackamas Community College was awarded \$65,070 to provide a *Lean Leadership Academy* to 27 workers of seven defense contractor consortium member companies. The academy targeted training for supervisors working in the defense logistics supply chain with the goal of educating participants on a number of key Lean tools and how to successfully implement those tools in multiple workplace situations. Perhaps most importantly, these leaders developed real-world experience and the confidence necessary to deal with everyday complexities of leading Lean.

The Manufacturing Training Consortium consisted of companies in the defense logistics supply chain that make and sell products (or components of products) whose end-user is the US Military. Table 1 summarizes each participating company by business name, location, and a summary of products produced.

Table 1 - Manufacturing Training Consortium Membership

Companies Served	Product Made and Sold	Company Location
American Steel	Plasma and Oxygen burned steel parts for WW metals, which further processes for them for Daimler who produces Heavy duty truck parts and mounts for the military.	Canby, OR
Benchmade Knives	Knives, Escape / Rescue hooks and related accessories.	Oregon City, OR
Leupold & Stevens, Inc.	Mark 4 line of riflescope products include MR/T, CQ/T, ER/T, LR/T, and are engineered to meet needs of military as well as the Tactical Binocular.	Beaverton, OR
Miles Fiberglass and Composites	Humvee Reinforcement kit for repairing and preventing cracks in Humvee hoods.	Milwaukie, OR
Northwest Technologies	Laser cutting and manufacturing of parts for replica targets for US Air force; Parts for unmanned aircraft systems	Estacada, OR
SAM Medical Products	SAM Splint, SAM soft shell splint, SAM Pelvic sling and Celox.	Portland, OR
Timbercon	Timbercon fiber optic products are used in a variety of military applications requiring rigorous testing use in harsh environments	Lake Oswego, OR

The *Lean Leadership Academy* focused on developing supervisory skills within manufacturing production facilities. The end goal of training was to increase cost effective and efficient manufacturing and development of current and new products.

According to industry representatives, there is an urgent workforce need to enhance Lean leadership skills of supervisors. These are the supervisors that have direct influence on the entry level manufacturing workforce. These individuals are often promoted to leadership positions because of their great work ethic and strong technical skills. However, while they may be familiar with Lean concepts and tools, they often have not received the important training in leadership to effectively implement such tools as: 5S, A3 Decision Making, Visual Management, and Value Stream Mapping. Improving the leadership skill sets of supervisors will strengthen not only the individual manufacturing companies, but the industry as a whole.

The *Lean Leadership Academy* training was designed with a classroom and a workplace component. The classroom component began with an introductory class. After the initial introduction, each class focused on one key Lean tool; its various implementation strategies;

how to teach others to use the tool; how to gain support for the use of lean tools; evaluation methods to measure the impact of the tool; and methods to overcome challenges to implementation.

The unique workplace component brought the classroom into the workplace. Trainees routinely visited one of the participants' company's and implemented a Lean tool, under the supervision of the course instructor and with input from the other class members. This allowed participants to see various work situations and the multiple scenarios for process improvement, as well as to experience real-world challenges. This practical application reaped benefits for the learners and also for the companies. In addition to these group learning events, students worked at their home company. Company-sponsored mentors worked with trainees to apply individual learning to activities at their work site. The training process culminated after twelve months with a student "capstone" project demonstrating real-world lean applications in each of the participating companies.

By the end of training, participants understood a number of key Lean tools and how to successfully implement those tools in multiple workplace situations. Perhaps most importantly, these leaders have developed real-world experience and the confidence necessary to deal with everyday complexities of leading Lean.

Lean Leadership Academy Training – Program Overview

Key elements for the Lean Leadership Academy for the Defense Logistics Supply Chain include:

- Hosted two Manufacturing Lean Leadership Conferences with representatives from private industry and partner organizations to provide input and direction in designing and implementing the *Lean Leadership Academy*.
- Leveraged work of the WIRED grant to reduce expense by using portions of curriculum already developed.
- Companies selected only qualified trainees for the program.
- Based on Consortium request, provided workshops on Wednesdays (8 hours) once per month for a period of twelve months. (44 weeks).
- College credentials were awarded at the successful completion of the training.
- Each workshop focused on one "Lean Leadership" topic. After each classroom session, trainees applied their new knowledge to a project in their "home" company. A company mentor monitored the trainee's progress and facilitated new learning.
- Evaluations of quality, effectiveness, and graduate success were completed to ensure the program met the needs of the industry.
- Training location varied between the college classroom, a Lean Learning Lab, and consortium company sites.
- Theory and principles were presented in an interactive classroom environment and a controlled Lean Learning Lab (for demonstration and experimentation).
- Real-world projects and applications ensure relevant transfer of training to the workplace.

Training Outcomes and Benefits

The *Lean Leadership Academy* supported companies in the defense logistic supply chain and enhanced the regional defense supply chain by:

- *Serving and benefiting defense companies of all sizes:* Participants became part of a network of defense manufacturing supervisors with similar challenges. This cohort delivery system effectively served small, medium, and large companies.
- *Focus exclusively on the defense manufacturing industry:* Participants learned lean leadership skills specific to the unique needs of the defense logistics supply chain.
- *Streamlining processes by improving lean leadership:* Leadership skills at the frontline of manufacturing in combination with Lean knowledge make for an effective implementation of lean concepts.

Myers Container/Stack Metallurgical Consortium

Myers Container was awarded \$97,600 to provide Lean training, Leadership training, and Kaizen events to 203 workers of two defense contractor companies.

Myers Container, LLC provides both new manufactured and reconditioned steel drums for commercial, industrial and military applications. Myers Container LLC operates 3 facilities within the City of Portland and employs 80 people. Myers' steel drums are used by 28 Military and Department of Defense (DoD) contractor/installations throughout the United States, and are primarily used to contain and ship hazardous waste generated by these military facilities. These drums are produced to a much higher standard and must be qualified for service within the military. Myers Container LLC is a critical link in the military supply chain as they are one of a very few qualified drum suppliers to the military and other DoD installations.

Stack Metallurgical Services, Inc. performs Heat Treating services for many military applications, of which Gerber Legendary Blades (a division of Fiskars Brands, Inc.) is their largest customer by volume. Heat Treating (*controlled heating & cooling to change the mechanical properties of materials*) is performed for Gerber Legendary Blades on components that make up specialized knives and multi-tools, many of which are specifically designed for US Military usage. Numerous parts are processed to meet the mechanical properties as outlined by specification requirements. The US Military prefers the knives and multi-tools manufactured by Gerber because of the high quality steel treating services, serviceability, and functionality, primarily driven by the heat treat processes provided by Stack Metallurgical Services, another critical link in the military supply chain. Stack Metallurgical has locations in Portland OR and Washington State.

Technical Change Associates Inc. provided training to these two companies to improve their products and services to the military, i.e. reducing lead times, improving quality, reducing costs, enhancing product utilization for end use, and working together with the product/service provider and the end user (Military) to create a better value proposition.

Technical Change Associates Inc. (TCA) trained the employees of these two companies on principles of Lean Manufacturing, which enhanced their ability to increase the value-added components of work, eliminate waste in the process, and improved their ability to view the entire value chain. TCA also trained them how to increase capacity, reduce lead times, improve quality, reduce cost, and to work with the supply chain members to improve the affectivity of the end product or service. Additionally, employees received training in production management and scheduling, built around the philosophy of capacity planning and availability of the workforce and equipment; so as to schedule capacity available to promise for on-time performance and optimization of the entire value chain.

Certificates of completion of courseware segments were provided for all employees completing the courses and who demonstrated the use of the learning in their respective positions. These certificates became part of the employee's personnel file and help to document training requirements needed for advancement and certification for key processes.

Training Outcomes and Benefits

- Ensured a delivery time to Gerber (a knife and tool manufacturer) of less than 24 hours on their parts. Heat treated parts for Gerber are eventually delivered to the US Military.
- Established a system to measure productivity and then improve productivity so as to meet increasing product demand from the US Military.
- The new drum washing process will eliminate approximately 95 tons of NOx emissions per year and reduce the energy levels required to produce the drums by 50%. The new drum washing process will enable higher throughput levels at a lower cost per drum to the US Military.
- Lean Accounting training focused on identifying the financial impact of Lean improvements. By using better tools in the make/buy decision process, the company can make better decisions within the supply chain to enhance the service to the US Defense. The workshop also provided a greater understanding of the cost structure and cost drivers. Some costing methods can lead to the elimination of thousands of transactions which is a cost savings.
- Lean Manufacturing Tools and Methodologies classes taught participants how to implement Lean in their perspective areas and as a company. The ability to see waste in the workplace shortens the lead time and improves on-time delivery. This workshop focused on the individual and their contribution to improving processes. The workshop also drove home the need for standard work and other tools that will increase the quality and decrease the number of defects. This, of course, will assure the DoD to receive products which are produced on-time, at the lowest cost and with the highest quality.
- The Production Management and Leadership Fundamentals course focused on process improvements coming from a leadership role. It is imperative for front-line supervisors to be able to make decisions at this level. It is important for these leaders to be able to develop relationships and the support needed to achieve the goals and objectives set forth by the customer and by the company. These participants learned the skills to make competent decisions that will save time and money for their areas. These leaders have learned to set up their areas to measure improvements and setup visual controls.

They have also learned the tools for problem solving. These tools will empower these employees to set up standards for their areas and gain the support needed to meet the expected quality and capacity. They have also learned how to coach their teams for success and process improvement at the shop level. These methods will be a great savings for the US Defense as they are able to solve problems, improve quality and eliminate waste

- The Vertical Racking Kaizen Event focused improvements needed to accommodate more space for incoming and outgoing material. Some of the congestion was due to the installation of a new furnace. The team was able to brainstorm ideas on better uses of floor space. These participants learned the valuable tools that help them organize events to implement critical improvements in a timely manner. Participants also learned how to measure improvements and utilize an effective problem solving process. In the future they will use this process to make continuous improvements and continually improve motivators because they can see rapid improvements in days and will continue to see improvements.

Kaizen Event (Drum Parts & Inventory Management)

This class focused improvements needed to organize, eliminate waste and better manage the inventory at Myers container. These participants learned the valuable tools that help them organize events to implement critical improvements in a timely manner. They also learned how to measure improvements. The participants learn how to order inventory using the demand as a signal to insure sufficient raw material to meet customer demand while minimizing the cost of holding raw materials. This allows for improved customer satisfaction and better on-time performance.

Kaizen Event (Production Scheduling)

This class focused on improvements needed to increase on-time delivery. Part of the problem was that there was no scheduling system in place. The lack of a scheduling system made it impossible to determine the true lead-time for customers. This event made all the participants better able to plan their work and predict the completion of work when it is accepted. The event defined a process for understanding facility capacity and available to promise capacity. This will give the promised delivery dates given to customers, including defense department contractors, more validity. When processing material in short lead-times with tight due date requirements it is important to understand the capacity, each participant is now equipped with the ability to plan and execute a daily schedule.

Lean Manufacturing Tools and Methodology: Management Alignment

This class focused on improvements needed and the management alignment necessary to coordinate the vision and strategy of the group. These participants learned the valuable tools that will help them organize events to implement critical improvements in a timely manner. The focus here is on creating standard measurements and clarifying the expectations among the management team. This critical training allows the management to be focused on what is

important and eliminates activities that were non-value added. This training will accelerate the rate of the improvements that will affect the US Defense.

Production Scheduling Phase 2

This class focused on improvements needed to increase on-time delivery. In a previous event, we created a scheduling system that helped them plan their work and predict completion dates. The development of this access data base now allows for creation of a daily schedule as information is downloaded from the current ERP system. This schedule will allow Stack to know their capacity available to promise and also the lead time to promise their customers including the defense contracts they currently serve.

Production Scheduling Phase 3

This class focused on improvements needed to increase capacity and scheduling which would also help improve on-time delivery. In a previous event, we created a scheduling system that helped them plan their work and predict completion dates. The development of this access data base allowed for creation of a daily schedule as information is downloaded from the current ERP system. Phase III of the project created daily work schedules for each department. This schedule is detailed to show the projected time for each order to start and shows priority of orders. This phase also allows the information flow to go down to the operator. The significance is that the operators can now load the schedule, expedite jobs and have more control to produce orders on time. This schedule will allow Stack to know their level of capacity and what to promise customers for the next order. This ability is critical to their customers; especially the defense contracts they currently serve.

Value Stream Mapping Kaizen Event

This class focused on valuable tools to help the group coordinate the necessary enhancements needed at the Marx Street facility. The focus was on mapping the processes to eliminate waste and determine the most critical areas needing improvement for increased cost savings and quality. This training will enable each participant to learn the techniques of Value Stream Mapping as a lean tool to consistently find areas to eliminate waste and improve flow. This Event also encourages team building and problem solving. This training will bring to the forefront improvements that will affect the US Defense.

Lean Manufacturing Tools and Methodologies

This class participated in a training/lab event to develop and implement a strategy for the new bottle storage area. This event was dedicated to establish inventory levels, measure sq. ft. needed for storage, develop visuals for replenishment and create standard work. The objective is to determine adequate inventory and establish lead times. This event defined a much needed process to improve productivity, reduce lead time and maximize labor utilization with the end result in a stable replenishment area for the new bottle storage. As this is implemented, Myers will be able to work with production to increase throughput through this area and satisfy lead times and delivery for the DOD.

A total of 21 participants were trained from both Myers Container and Stack in a two phase course on Maintenance Best Practices.

Phase I - This class focused on the 6S Lean tools for organizing the Maintenance department—specifically the storage area. Identifying spare parts and stock inventory will be a first-step in time wasted trying to find parts. The next step the team focused on was to maximize the existing storage area. It was the team's consensus that there was too much space being wasted due to the clutter and disorganization. The area was cleaned, organized and labeled. Parts were identified and recorded into the computer for immediate location. This Event maximized the current storage area, created a methodical inventory process which decreases the time to locate parts and eliminates purchase of excess parts. This was a perfect event to lead into Phase II.

Phase II - This class participated in a training/lab event to develop the Computerized Maintenance Management (CMM) system at Stack. This training and event helped Stack to develop an inventory and ordering system that will enhance and sustain the improvements listed in Phase I. Due to all the data entered, the computer can produce reports that will list parts needed to be ordered and provide a current inventory. A standard process was developed for all Maintenance personnel. The maintenance department is a critical area that affects the lead times throughout the facility. This event reduced time wasted looking for parts, ordering duplicate parts, and maximize the labor utilization in that department. As this improvement process continues, Stack will be able to target levels of replacement and maintenance parts. This planning will assure reliability of equipment and allow planning for any downtime.

The other portion of this event entailed a process redesign of the Plastic Recycling Grinder area at Myers. The members participated in a formal training to understand the grinding equipment and processes to enable them to redesign for improvements. The outcome was a new process that reduced the workload, increased productivity, standardized the work process and decreased the downtime of the line. They will also be continuing to build new parts for the equipment which will enhance the process as well.

The Oregon Manufacturing Extension Partnership (OMEP)

OMEP was awarded \$41,730 to provide Lean Manufacturing training to three companies and an estimated 45 workers. Companies trained by OMEP committed to providing a 1/3 cash contribution to increase the amount of training provided with contract funding. Five companies were supported as part of the project: SAM Medical, Warne Mfg., PECO, Wolf and NW Signal.

OMEP provided Lean Manufacturing training services on this project using its proven "Learn and Do" approach. Classroom training was followed by a guided practicum/ implementation during which employees applied Lean principles learned in class directly to workplace processes that support the manufacture of military-related products or components. During the practicum, OMEP provided mentoring and coaching to employees and developed Lean Champions who were charged with leading Lean initiatives during the course of the project and beyond the end of the contract period.

NW Signal

To get everyone on the same page with respect to Lean and prior to starting the application or hands-on practicum phase, the first order of business at Northwest Signal Supply has been to provide Principles of Lean Manufacturing and Value Stream Mapping training to employees. The training and subsequent guided application or practicum will be used to improve production of, among other items; EL Displays which are used by the military.

Employees completed critical foundational training in Lean with Value Stream Mapping (VSM). As part of the VSM class, employees generated a Current State Map of their manufacturing processes, identified opportunities for improvement, and developed a Future State map. Based on the future state VSM employees developed a project plan for implementing improvements which includes responsibilities and a time line.

As part of the VSM training & practicum, NW Signal employees mapped a couple of the company's information systems: 1) RFQ process and 2) From Purchase Order to Work Order hitting the production floor. Numerous opportunities for improvement were identified. Employees developed a future state map and implementation plan then began to identify obstacles and how to remove them to advance improvements.

As part of the VSM process, standard costs determination and labor data collection processes were explored. Also, employees toured the AmFor facility to explore outsourcing of cabinet wiring and to determine if AmFor was capable/interested in doing the work.

SAM Medical

Lean training efforts at SAM Medical revolved primarily around Standard Work – applying Lean methods to deal with production demand fluctuations. This included determining key positions, analyzing each work station, and identifying a core team of skilled employees which would be augmented by temps to meet temporary production increases. A review and continued improvement of the new facility layout was also accomplished. All work affects SAM's military lines of products.

Standard Work: OMEP conducted Standard Work (SW) training in the main part of the Splint Line including Screen Print, Rolling/Folding, and Packaging. A review of existing SW documents was made and recommended revisions were noted. A small amount of 5S was included in the session.

Design for Manufacturability: Participants reviewed the assumptions and data collected to date to bring the SAM Sling in-house. The team is going to experiment with different designs for a particular component of the product. The ultimate goal is to shave 20% off the manufacturing time.

Warne Scope Mounts

Value Stream Mapping and Problem Solving training efforts have been primarily focused on surface finish quality issues in the aluminum value stream, Heijunka concepts have been applied to level production and manpower, and Lean Management training has been aimed at

management's role in sustaining improvements. All are applied to scope mount manufacturing which predominantly supplies the military and hunters.

Warne continued with improvements on the aluminum value stream by the following the existing training plan:

- Trained supervisors on Lean Management Systems
- Trained on Future State Value Stream Mapping
- Applied in practicum 5S, Current State Value Stream and Future State Value Stream Mapping concepts

Warne completed its grant funded activities with Advanced Lean Concepts training for the Lean Coordinator and Shop Manager. Training activities throughout have been focused on the aluminum value stream which supports their military product lines.

PECO

Principles of Lean Mfg. training provided a baseline of Lean understanding and skill-building in the workforce. As part of the 5S training, the group worked on organizing half of the injection molding area. Employees also worked on applying Set-up Reduction principles to one of their Aluminum Die Casting Machines.

Wolf Steel

Value Stream Mapping training and practicum provided by OMEP laid the foundation for the company's plans for its Hubbard facility. With a focus on product flow, they were able to then work on developing an efficient plant layout and to determine a capital plan that aligned with their strategic plan.